EFFECT OF DIFFERENT BODY CONDITION SCORE ON THE REPRODUCTIVE PERFORMANCE OF AWASSI SHEEP

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For those who by their education, love and encouragement

have been made from me what I am today

To the candle of given and sacrifice my father, Georges

To the angel of love and tenderness my mother, Marcelle

To my three sisters that have a great part in my success, Sandra, May and Rola

To my lovely person and my soul mate, Youssef

To my little angel Lea

To all of them I dedicate my work

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LIST OF ABBREVIATIONS

BCS	= Body condition score
df	= Degree of freedom
cm	= centimeter
EAAP	= European Association for Animal production
FAO	= Food and Agriculture Organizationof the United Nation
g	= gram
GNP	= Gross national product
Kg	= Kilogram
SW	= Small weight
H	= Hoggets
LW	= Large weight
M	= Multiparous
P	= Primiparous

1 INTRODUCTION

Small ruminants breeding represents one of the most significant agricultural activities in the world and it plays a fundamental role on economic, ecological, environmental and cultural levels (Zervas *et al.*, 1996). It constitutes, in particular in the mediterranean area an effective transformation of thousands of marginal hectares into animal protein of high quality (Boyazoglu and Flamant, 1990).

Small ruminants account for 30 - 40% of the value of agriculture output in near eastern countries (Bahhady, 1986; Nygaard and Amir, 1987). However during the last decades, small ruminant production in the near east region has been facing major obstacles in particular feed shortages (Nordblom and Shomo, 1995). As a result, the sustainability of these systems is at stake (Steinfeld *et al.*, 1998).

Small ruminants still play an important role in the Lebanese Agriculture (FAO, 2004). A recent survey on the small ruminant systems indicated that small ruminant production was undergoing drastic changes in response to major constraints (Hamadeh *et al.*, 1996, 1999). Marginal lands were increasingly used in crop production and become less available to livestock production and feed availability was identified as a major limiting factor to small ruminant production.

The Lebanese government has set itself the major goal of improving livestock production in order to raise livestock farmers' income and living standards and guarantee food security in animal products. At the same time, these initiative will help develop the local food industry and reduce dependence on imported products, which, these days, are often cheaper than those produced locally. An increase in self-sufficiency in food would help build the national economy (Hilan, 2005).

The livestock sector accounts for one-third of the gross national product (GNP) of the agricultural sector in Lebanon. Between 1993 and 1995, milk and dairy products accounted for 40% of the GNP from livestock, of which 63% came from cows, 10% from sheep and 27% from goats; meat accounted for 24% of the GNP, with 32% from cattle, 47% from sheep and 21% from goats. Poultry products represented 32% of the total, 84% as meat and 16% as eggs.

Hilan (2005) reported that Lebanon imports 82% of its requirements for meat, 100% of its milk powder and 53% of its cheese and butter. A survey conducted by the Ministry of Agriculture in collaboration with the Food and Agriculture Organization of the United Nations (FAO), published in 2000, showed that in the short term

Lebanon will find it difficult to attain any appreciable level of self-sufficiency as far as meat from cattle and sheep and milk and dairy products are concerned.

Small ruminants breeds (sheep and goats) of Lebanon have been historically important components of rural Lebanon and still fulfill a sustainable role in the livelihood of farmers. The country has a tradition in the consumption of small ruminant products. Its production is favored by a growing demand and favorable prices (Hamadeh *et al*., 1996, 1999).

According to recent statistics published by FAOSTAT (2005), there are 350,000 sheep, including 315,000 milk sheep. However, this number remains insufficient to supply the needs for the local market.

The annual averages of sheep carcasses produced between 2001and 2003 were 3000 tonnes. The estimated average annual output of milk during the same period was 32,000 tonnes (FAO, 2005).

Originated from Syria, Iraq and Turkey, the Awassi is the most popular fat tailed sheep in the near and Middle Eastern region (Jasim *et al.*, 2006). Most of the sheep are kept in extensive and semi-sedentary systems, where productivity is low.

In nomadic flocks, the animals travel long distances when feed and water are scare (Eyal, 1963; Rottensten and Ampy, 1971; Bhattacharya and Harb, 1973; Bradford and Berger, 1988). Awassi sheep are generally raised in semi-arid areas characterized by a period of drought and hot temperature during which the animals suffer from increase in temperature and lack of feed and water. Under these conditions, the animal is obliged to mobilize its own fat reserves stored in the fatty tail called "reserve of energy "(Hafez, 1968; Epstein, 1985). In traditional breeding, met in Lebanon, sheep are raised near houses and are managed by a family. Grazing takes place on agricultural area plains and surrounding range lands. Animals generally survive on residues of agricultural cultures of which the availability and quality are functions of the season.

In the Middle East, sheep are raised in a traditional manner. However, the modern way is to raise these animals under intensive systems using estrus synchronization, super ovulation and artificial insemination to improve their genetic characteristics and potential. Proper management using synchronization, breeding and better nutrition are means to improve the production performance of the Awassi sheep (Abi Saab *et al*., 2000).

Atti (1991) announced that in difficult environment such as the travel of long distances in the Middle East, feed availabilities are not sufficient. Abi Saab *et al.* (1998) showed that the vegetation in Lebanon presents a better food value during spring and beginning of summer. This is due to snow melting at the end of winter, which starts the development of annual plants with high proteinic content. These annual plants will die progressively with drought. Under these conditions, the animal will be obliged to mobilize its fat reserves as physiological response to feed reduction (Blaxter *et al.* , 1961). Kabbali *et al.* (1992) have shown that loss of weight consisted of protein, fat, and water and that the extent of each of these components involved was dependant on the severity and duration of the weight loss, the maturity of the animal, and the composition of the diet. Caldiera and Vaz Portugal (1991) added that the availability and the quality of the pasture yield are subject to seasonal variations. This alternation in grass availabilty to grazing ruminants is counteracted by the animal's physiological mechanisms of mobilization and deposition of body reserves or, stated in another way, by changes in body condition. Drought conditions restrict animal productivity and make metabolic adaptation responsible for production level and efficiency at which the animal maintains its physiological parameters.

Several studies showed that the formation and deposition of fat in sheep starts after a certain age and depends on sex, age, stage of maturity, physiological state and feeding condition (Deddieu *et al.*, 1991; Fourrie *et al.* , 1970; Miller *et al.* , 1986; Banskalieva *et al.* ,1988; Petrova *et al.* , 1994; Webb *et al.* , 1994). Banskalieva (1996) added that the quality and cost of sheep production are determined to a great degree by the quantity and the composition of reserve fats.

Marie *et al.* (2000) announced that the fat tissue secretes hormones such as leptin, having effects on reproductive parameters, and their concentration is a function of feed availability; thus, the mobilisation and the accumulation of fat in sheep are accompanied by a variation of the reproductive performances of Awassi sheep breed.

Atti (1991) added that the interest of body reserves in adult animals, in particular in reproductive females is known; They have a great nutritional role. At certain stages of the reproduction cycle, whatever the feed level, the mobilisation of the reserves is inevitable to build the energy deficit caused by the physiological state of the animal (Blaxter *et al.* , 1961). Bocquier *et al.* (1988) added that a good nutrition of ewes, i.e. most economic without reduction of performances, is based on a good management of body reserves. It is thus essential to estimate them during each phase: first at weaning, second during gestation, and third at lambing. These body reserves could have effects on the reproductive capacities of the ewes (prolificacy, fertility, puberty). Thus, Gunn *et al.* (1991) found that conception and lambing rates increased significantly with increasing body condition score up of scores 2.5 to 2.75 and decreased significantly below these levels. These results are also reported by Molina *et al.* (1994) and Smith (1985).

In addition, for the Awassi breed, the accumulation of fat is done primarily on the level of the tail, a surplus of fat can reduce the mating act, increase the larval infestation rate and interfere with the normal locomotion of the animal like shown by Zamiri and Izadifard (1997). Also, the development of fatty tail could have effects on the reproductive parameters (fertility, puberty) of rams and ewes (Zamiri and Izadifard, 1997) and on the comfort of the animal (Shelton, 1987).

The relations fat reserves, breeding system and reproductive capacity, once established, make it possible to elucidate the conservation of reserves if the mobilisation would be increased or decreased as well as provide an update on the most adequate breeding system for animal body development without harmful effect on its fertility.

The improvement of the reproductive capacities (fertility, puberty) and productivity (body growth) accompanied by modifications on the level of the size of fatty tails involves an improvement of the profitability of the breeding flock.

Thus, the aim of this study was to determine the relationship between ewe body condition and reproductive performance in the fat-tailed Awassi breed.

Objectives

The overall objective of this study was to estimate body dynamics in Awassi ewes in order to understand and manage the genetic ressources and their effect on reproductive performance under different management systems and different geographical areas in Lebanon. In order to achieve these objectives, we conducted two experiments, estimating body condition score and reproductive performance. These experiments allowed us :

1. To establish relations between:
   - The body condition score, dimensions of the fatty tail and the evolution of body measurements.
   - The body growth, tail growth and the reproductive performances of the females (rate of gestation, rate of parturition).

2. To determine the effect of supplements (improved system) on the reproductives performances of the females during reproduction period.
3. To improve understanding of performance processes in Awassi sheep as a contribution to improved utilisation of this important genetic resource.

Therefore, in order to achieve these aims, the experiments related to the thesis project, were conducted in two directions (experiments); Part of the first experiment, was the result of a research project implemented and executed at the Holly Spirit University of Kaslik, Lebanon, under the supervision of Prof. Dr. Saab Abi Saab for a master degree; This experiment was carried out in a traditional breeding flock in the mountain region at Bekaa valley at Lebanon on adult females (primiparous and multiparous) and hoggets gathered in various groups according to their body weight and the adopted breeding system (traditional or improved) and considered as an intial trend of research with various axes to be developed! This part constitutes (in fact), in our present work, the stem of the study, followed by the actual axe (main body of research): the stasitical analysis and experimental measurements added and presented as the study of the relationship between body conditions and reproducitve performance (fertility and prolificacy).

The proposed second experiment was conducted in five different flocks from five different agro-ecological regions of Lebanon (Mount-Lebanon, Central Bekaa, Hermel, South-Lebanon, North-Lebanon) on adult females (primiparous and mulitparous); one flock was selected from each region from ten volunteer breeders. Parallel to the first experiment, females in each flock were gathered in various groups according to their body weight and the adopted breeding system (traditionnal or improved). This second trend emphasized the relationship between ewe body condition score and reproductive performance of Awassi ewes under different environmental and breeding conditions and reserved to analyze the huge data gathered during my daily work at the Small Holder Livestock Rehabilitation project – Ministry of Agriculture, and in parallel, through the Lebanese University, where I was recommended to my PhD study. This work is actually supervised by Prof. Dr. Kurt Peters at Humboldt University Zu Berlin.

The measurements (second experiment) aimed to study the effect of different geographical regions on growth parameters of Awassi ewes and consequently their impact in the reproductive parameters.

2 REVIEW OF LITERATURE

2.1 Approaches to animal genetic resource evaluation

There is strong evidence that, more than 10000 years ago, the domestication of sheep took place in Asia, a known center of diversity for a number of domestic animal species (Luikart *et al.*, 2001; Nowak, 1999). It is likely that these species were dispersed from this area to other regions. It is also probable that West Asia became an area of exchange between the East and West via the "Silk Road", one of the most important routes connecting Asia with Europe in later time. The various breeds of sheep today are adapted to a range of arid and semi – arid environmental conditions.

There are nearly 278 million sheep in the world (FAO, 2004). Sheep together with the other classes of livestock make a substantial contribution to the well being of multitudes of people around the world in the form of meat, milk, fibre and skin. Sheep production contributes to the agricultural economy of countries. This is more prominent in developping countries than in developped ones. Ponzoni (1992) has reported that currently there seems to be a greater awareness of the need to identify, characterise, preserve and improve indeginous breeds which are thought to have some valuable attributes that could be used at present or some time in the future.

Man has for a long time been manipulating and altering the genetic composition of livestock through crossbreeding, selection and inbreeding (Mandalena, 1993).

According to Lahlou – Kassi (1987) and Peters (1989), a comparative small ruminant performance evaluation will adress the following issues:

- Adaptation traits: these are some of the most important phenotypic traits which in one way or another might influence the adaptability of the animal to the prevailing environmental conditions (tolerance to diseases, parasites, heat…).

- Reproductive traits (female reproduction performance such as age at puberty and first lambing, conception rate, prolificacy, male reproduction performance…).

- Production traits (birth and weaning weight, growth rate, caracass yield and quality, fiber yield and quality…) and survival rate.

The usefulness of genetic diversity among livestock breeds in enabling producers to meet new goals in animal production, which arise from the changes in consumer demands and also changes in economics of livestock production, has been known for long (Dickerson, 1969).

In developping countries, livestock genetic resources in general have not been adequately characterised, evaluated or fully utilised through selection and in some cases local populations are threatened with extinction before their genetic value is even properly described and studied (Madalena, 1993). Similar to other classes of livestock, the genetic diversity in sheep can be expanded by the development of synthetic breeds through crossbreeding to combine the most important traits of economical and adaptation significance (Maijala and Terill, 1991). The role played by geographic isolation in influencing between breed differences to special products, characteristics, and phenotypic appearances has also been emphasised (Maijala and Terill, 1991). They have stated that the most important between breed variation observed was the specific adaptability of breeds to the prevailing climatic and feeding conditions within ecosystems, and these ecosystems range from sparse to ample feed and forage, desert to high humidity, from sea level to high mountains, from the equator to the northern and southern hemispheres.

The choice of the right type of animal to be raised in an area where it is best adapted results in higher productivity (Madalena, 1993). Therefore, considering the importance of environmental components such as improved management practices and nutrition in enhancing higher productivity, indigenous breeds not only do survive but also do produce under harsh and uncertain environmental conditions.

Appropriate genotypes must be used in environments where they can best express their inherent genetic potential (Madalena, 1993). Attempts to improve further the inherent genetic capacity of any livestock population beyond the scope of the nutritional or improved health care practices under which it is maintained will be counterproductive (Timon, 1993). As indicated by Laes – Fettback and Peters (1995) and Vercoe and Frisch (1987), it is thus necessary to identify the merit of available genetic resources, the possible integration of the animals into various production systems and to make effective use of their potential in order to quantify existing breed differences according to growth rate, growth potential and the response of the animals to different feeding challenges. Where feed supply is a major limiting factor, it is of paramount importance to look into both biological and economical factors affecting livestock productivity (Al Jassim *et al.*, 1996).

The real value of indigenous breeds is often under estimated mostly due to their poor appearance and relatively low productivity. Peters (1989) reported that there is an apparent lack of information regarding the identification production problems, possible interventions and performance of animals within existing production systems in order to properly utilise the available genetic diversity to enhance production. This is particulary true in developping countries, where breeds or types of livestock have not yet been fully identified and characterised, despite the fact that indigenous breeds survive and produce under unfavourable environments and limited availability of feed; above all they are alsointegrated parts of the prevailing entire production systems.

Currently, understanding has increased (Seré and Steinfed, 1996) that introducing high yielding breeds of livestock and specialised modes of production in new areas can lead to a loss in genetic diversity among indigenous animals. However, in developping countries, the less intensive production systems are based on the existing species and breed only. It is, therefore, absolutely necessary to evaluate existing livestock genetic resources from a stand point of matching available genotypes with the environment under which they are expected to be maintained.

2.2 Economic sustainability of sheep production in Near East and Lebanon

If small ruminants at all play a significant role in the Lebanese Agriculture (FAO, 2005), where they are present, they represent a less developped sector (extensive breeding system, manual milking, traditional transformation of products). During these last years, a progressive decline in number of the local livestock race (-17%), based on grazing as a principal food, has been noted (RGA, 2002); this has created a necessity for production improvement. The reduction in number is mainly due to the expansion of agricultural lands (Zurayek *et al.*, 2001; M.A., 2001) or due to touristic projects (The Sannine _ Zenith project will use 1000 ha of land) in the mountains to the detriment of pastures available for small ruminants.

A recent survey identified the prevailing small ruminant systems and indicated that small ruminant production was undergoing drastic changes in response to major constraints (Hamadeh *et al.*, 1996, 1999). Marginal lands were increasingly used in crop production and becoming less available to livestock production, thus feed availability was identified as a major limiting factor to small ruminant production.

The use of agro – industrial byproducts was reported to partially fill the gap between supply and demand for conventional feed resources in the region (Hadjipanyiotou, 1992, 1993). Further more, a simple technique has been developed to process byproducts into feeding blocks. A study conducted by Bistanji *et al.* (2000) indicated an abundance of byproducts available year round in Lebanon; however only a small proportion is being presently used as feed sources for livestock.

There are other limiting factors, economic, social or otherwise, to alter the livestock production environment for high yielding improved or temperate breeds; the process to continuous by improve the indigenous breeds for higher productivity can never be overemphasised (Setshwaelo, 1990).

The economic benefit of sheep production could be enhanced by increasing the efficiency of growth to the desired market weight. As explained by Ruvuna *et al.* (1992), the existence of breed differences in caracass characteristics allow to choose breeds to match specific production objectives.

It has been known for long thaugh (Bradford and Berger, 1998; Dickerson, 1996) that the most effective livestock improvement can be attained by effectively using animals already adapted to a particular environment. As defined by Terrill and Slee (1991), adaptability is the ability to survive and be productive under whatever environment or combination of environments at which the animals are maintained.

The identification of adapted breeds, which are relatively superior in important productivity indices will therefore provide means of enhancing production at no additional input costs. However, there will always be a need to address the whole question of relationships between the nature of the production environment and the objectives of breeding programmes in the context of the level of production and adaptation. Dickerson (1973) has reported that multiple births and long breeding seasons in meat sheep can be beneficial and could also reduce costs of breeding flocks if appropriate nutrition, housing and labor are provided, but that targets cannot be achieved under stressfull range conditions.

2.3 Importance of Awassi sheep breed in Lebanon

Awassi sheep had been historically important components of rural Lebanon and still fulfill a substantial role in the livelihood of farmers. The country has a tradition in the consumption of sheep products and as the country stabilizes and people’s income increases its production is favored by a growing demand and favorable prices.

Awassi is the only indigenous sheep breed in Lebanon. The name of the Awassi is attributed to the El-Awas tribe between the tigris and Euphrates rivers.

The Awassi breed is known for its ability to withstand harsh climatic and environmental conditions, the good growth of lambs, and milk production potential. Although the Awassi is a triple purpose breed, they are kept in lebanon mostly for meat production, and to a lesser extent for milk production to suit the needs of the family. It is the most prominent breed of the world for quality mutton production (Choueiri *et al.*, 1966; Mason, 1967; Abi Saab and Sleiman, 1993; 1995).

According to Gatenby (1991), sheep are raised, because they produce, in addition to meat and milk, wool and pelts, draught power and manure; they are also a form of investment in countries where no other financing facilities are available and where the individual farmers do not own land. The breeding of small ruminants such as sheep - rather than large ruminants – requires moderated cost and has need only for little food. In addition, costs of a sheep are much lower than that of cow, and a small farmer can pay the expenses of one or two ewes, but not of one cow.

The number of Awassi sheep is in continuous but very slow progression; The total number of sheep was estimated at 278 000 head kept by about 4500 keepers and distributed mainly in the Bekaa (56.5%) and in the north (24.4%). The sheep population is distributed across 5245 owners with an average of 72 animals per flock. The largest average flock size (150 animals) is also among landless owners, representing a little oner 18% of sheep farms and 38% of the total sheep population (FAO, 2006). Hamadeh *et al.* (1996) also reported that the plain of Bekaa gathers more than 50 % of the sheep raised in Lebanon which are raised in three sedentary types of breeding, nomadic and semi-sedentary systems in the plain. They added that this plain produced about 70% of the total roughages eaten by sheep in Lebanon.

Abi Saab and Sleiman (1986) added that the Awassi sheep are dispersed throughout the plains and the mountains, living in vertical and horizontal continuous transhumance and being subjected to high temperatures.

Gatenby (1991) identified that the majority of the Awassi sheep in Lebanon are kept in nomadic flocks which move towards other areas during certain periods of the year. During the dry season, the flocks graze in the areas with a high rate of precipitation in the valleys. Usually, these migrating sheep graze 12 to 16 hours per day, and cover a distance of 8 to 12 km/day. The Bedouins rotate every season in a cyclic and rhythmic way in search of pasture and water (Bhattacharya and Harb, 1973). The Bedouins leave towards Syria during the winter.

2.4 Ecosystems pertaining to sheep production in Lebanon

Due to its climatic diversity, with more than 9 different ecological and climatic zones and its relative self-sufficiency in water resources (FAO, 1996), Lebanon, with a surface of 10452 km^2, is since a long time a producer of several varieties of agricultural products, in particular those of animal origin.

Located on the Eastern shore of the Mediterranean sea and surrounded in the north and in the east by Syria and also by Israel, Lebanon is a primarily mountainous and coastal country; representing a narrow band of 217 km length of territory in the northern – south direction and 40 to 80 km broad east – western band. The country surface is located at a northern latitude between 33 ºC and 34.5 ºC and a longitude between 35 ºC and 36.5 ºC (FAO, 1996).

According to ICARDA (2005), three main agricultural regions prevail:

- **Coastal:** this area has an elevation of up to 500m and is characterized by moderate temperature, high rainfall (600 -1000mm), and high humidity. The agricultural area includes the plains of Akkar in northern Lebanon and the small coastal plains in the south. The agricultural production involves cropping (wheat, barley, forages) and horticulture.

- **Mountainous:** the western slopes of Mount Lebanon (facing the sea), with an elevation of 500 to 16000 m, are characterized by moderate temperature and high rainfall (800 – 1400 mm). This ecosystem extends from the north to the south of Lebanon. Cultivated areas involve fruit production (apple, pear, peaches) and limited cereal production. Most of the cultivated land is covered by forests (pines and oaks) and shrubs.

- **The Bekaa valley:** this area forms the largest plain from Lebanon and is situated between the Lebanon and the anti – Lebanon mountain chains. The elevation varies from 700 m in the south (western Bekaa) to 1200 m in the North (Baalback).

Rainfall ranges between 600 and 700 mm in western Bekaa and as low as 300 mm in the north (Baalback and Hermel). The weather is very cold in the winter (minimum of – 15° C) and very hot in the summer (maximum of 45° C). The Bekka valley production includes agricultural crops (wheat, barley, forages) and horticulture.

The majority of the sheep breeding systems adopted in Lebanon are extensive (nomadism and transhumance). These systems are based on the use of natural pastures and of agricultural by-products, resulting from traditional cultures and fallow areas. Addition of supplements is practised only during certain periods of the year (Treacher *et al.* , 1992).

The agricultural resources in Lebanon are considered limited because of the nature of the ground and its installation. The spontaneous vegetation in the pastures in Lebanon comprises shrubs, hardy perennials and grasses whose majority grow during the seasons of winter and spring (ACSAD, 1986; 1996).

Following a study made on the sheep flock in Bekaa, Abi Saab and Hamadeh (1984) concluded that sheep herds show a seasonal sexual activity. Mating takes place between June and November with a maximum rate of conception between August and September. Lambing takes place between November and May. Hamadeh *et al.* (1996) added that the contribution of supplements is essential during autumn and winter (November-March) corresponding to the period of end-pregnancy and the beginning of lactation. Supplement constitute 85% of the ration provided to sheep during this period and in the three types of husbandry systems (sedentary, nomadic and semi-sedentary). The quantity of supplements offered varies between 165 kg/head/year in the sedentary system and 105 kg/head/year in mobile herding.

In the same context, Treacher *et al.* (1992) printed out that natural pastures offer the principal ration between March and May. They added that grazing in rangeland may make a slightly greater contribution to protein intake than to energy intake, as the protein content of many range plants, especially in spring, is higher than that of many feeds used. It seems probable that substantial savings in feed could result from eliminating grazing in rangeland in winter and early spring, when herbage growth is negligible and feed requirements are high, to feed a correctly formulated diet that includes mineral and vitamins. This period corresponds with the end of pregnancy and the beginning of lactation, periods during which the energy and nutritional needs of animals are on their highest levels. These authors added that the energy cost of walking large distances (5-8 km/day) to graze very sparse vegetation for most of the year may exceed the intakes of energy from the herbage. The small intakes of herbage may, however, be critical in preventing mineral and vitamin diffeciencies in the current systems, in which mineral and vitamin supplements are not fed.

2.5 Constraints facing sheep production in Near East and Lebanon

Lebanon is relatively rich in natural resources. However, the absence of environmental management led to an alarming degradation of these resources like deforestation, erosion, water and air pollution, destruction of the marine environments (ERM, 1995; Masri, 1997; Owaygen, 1999; Osman and Cocks, 1992). Some of these deficiencies are due, during these last decades, to the civil war, which entrained strong water pollution in Lebanon; the systems of collection and treatment of waste have ceased functioning during the periodes of hostilites (Corm, 1997).

Following war, the need for economic rapid development and for projects of rebuilding was gitten priority. The environmental impact associated with these projects was given secondary importance.

The major constraints facing sheep production summarized by ICARDA (2005) are as follows:

Nutrition

- Limited local feed resources, lack of crop residues and high cost of imported feed,
- Poor, unbalanced, livestock diets during winter.

Health

- Low resistance to diseases such as enterotoxaemia, foot-and-mouth disease, colibacillosis and sheep pox, to internal and external parasites, contagious diseases, brucellosis and other zoonoses,
- Inadequate veterinary services, lack of vaccination campaigns, high cost of medication and lack of hygiene.

Socio-economics

- Lack of extension programmes to improve traditional practices and popularise new production methods,
- Poor communication between farmers, veterinarians and the Ministry of Agriculture,
- Lack of an official pricing policy and problems with availability of credit for farmers,
- Low prices of imported milk and dairy products,
- Lack of milk collection, storage and marketing centres,
- Lack of meat quality control and of slaughterhouses standards.

Environmental

- Poor organic waste disposal,

- Destruction of rangelands and woodlands.

2.6 Production system and management

Awassi sheep are raised extensively in large herds of 200 to 500 animals, managed by a family. Grazing takes place on agricultural area plains and surrounding rangelands. As in all systems in West Asia, there is a period of 100 -150 days when the animals are dependant on hand – feeding (Treacher *et al.*, 1992). Hand – feeding is practised in many flocks during the early summer mating season and in the late pregnancy and early lactation periods, all being times of high nutrition requirements.

Table 1 shows the seasonal features of Awassi sheep management**.**

Table 1: Seasonal features of Awassi sheep management

Events	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Mating												
Pregnancy												
Lambing												
Lactation												
Grazing												
Stubble feeding												
Concentrate feeding												
Antiparasite treatment												
Shearing												
Climatic conditions	Winter: wet and cold			Spring: mild temperature and vegetation growth			Summer: hot and dry			Fall: progressive cooling wet season starts in october		

(ICARDA, 2005)

Five types of production systems have been identified in Lebanon by Srour *et al.*, 2004:

1. **Vertical transhumance**: adapted to different breeding conditions. Absence of cultivated area and valorization of milk by transformation into cheese, yoghurt, Labneh..

2. **Sedentary**: presence of cultivated area of vegetable crops, mountain pasture and sale of local products.
3. **Semi – nomad**: specific of Bekaa, mixed flocks of big size, pasture on land rented in plain and mountain area, and sale of milk to industries.
4. **Horizontal transhumance**: mainly in the areas of abundant plain cultivation of forages and vegetable crops; sales of milk to industries.
5. **Dry lot**: practiced with foreign high – yielding dairy breeds without pasture.

2.7 Performance characteristics of Awassi sheep

2.7.1 Phenotypic characteristics

Eighty - five percent of Awassi sheep are predominantly white with a mostly brown head and legs. The other color variation found are white gray, spotted or all white heads, and occasionally, white forhead patches. Accordingly, Mason (1967), it considered that the Awassi sheep are robust. The rams have a size of 70-80 cm, a weight of 60-90 kg and a convex head. They have long spiral horns (40 cm). They are very seldom dehorned. Ewes have an average size between 60-70 cm, a weight of 30-50 kg and a straight head. Sometimes up to 25% of them have short horns up to 10 cm. The ears are long (approximately 17 cm) and hanging.

The productive capacities of Awassi, even those well acclimatized, are considered under – developped and could be improved by introducing selected exotic prolific traits (Fox *et al.* , 1971; Mabrouk *et al.*, 1977; Goot *et al.* , 1979; Abi Saab and Sleiman, 1986). Abi Saab and Sleiman (1995) thaugh showed that the hybrids resulting from such a crossing between Awassi and exotic hybrids (Finn Landrace and Texel) have difficulties to adaptat to the conditions of the extensive systems in Lebanon. As for the Awassi meat, it is the most preferred red meat in Lebanon and in the Middle East. In fact, this meat has a good organoleptic quality with a low fat content because the accumulation of fat around the tail reduces the quantity of intermuscular and intramuscular fat (ACSAD, 1996).

According to de la Fuente *et al.* (2006), the interest in the Awassi breed lies primilary in its ability to produce milk in the semi – extensive systems to which the Awassi breed adapts easily, as it is a hardy breed. However, for intensive systems improved Awassi breeds and the Assaf (Awassi X East Friesian) achieve higher total production.

2.7.2 Growth performance of Awassi sheep

The Awassi ewes reached an average live weight of 45 kg at 2 years of age and a mature weight of 57 kg at four years of age (Rottensten and Ampy, 1971), while rams will reach 90 kg at 3 years of age. Single lambs had an average birth weight of 4.6 kg for males and 4.3 kg for females. Twin lambs were about 20 % lighter than singles. The corresponding weaning weight at 2 months of age was 17.9 and 16.8 for singles and 13.4 and 12.4 for twins.

The growth rate, particularly during the early stages of growth, is strongly influenced by breed, milk yield of the ewe and the environment under which the animals are maintained, including the availability of adequate feed supply in terms of both quantity and quality (Laes-Fettback and Peters, 1995).

As stated by Owen (1976), growth rate of lambs increases until the point of inflection which is attained when the animals are between one and five months of age. After this point, the animals continue to increase in weight but at a declining growth rate as they approach maturity.

Birth weight is strongly influenced by breed (genotype), sex of the lamb, birth type, age of dam, feeding conditions, season of birth and production system (Gatenby *et al.* 1997; Rastogi *et al.* 1993; Gatenby, 1986; Tuah and Baah, 1985; Dickerson *et al.* 1972). The birth weight of animals is one of the most important factors influencing the pre-weaning growth of the young. Martinez (1983) has reported a positive correlation between birth weight and subsequent live body weight development in sheep. In another study (Gatenby, 1986), it is stated that lambs heavier at birth grow faster than light weight lambs. Lambs which are heavier at birth are usually singles or are those produced by ewes with larger body sizes and good feeding conditions. The indication is that lambs heavier at birth reach a higher adult weight and have a higher growth capacity. Improvement in birth weight is known to have a positive influence on other productivity parameters. Birth weight itself is affected by dam size, dam body condition and litter size and influences the survival rate and pre-weaning growth performance of the offspring's as confirmed by Laes – Fettback and Peters (1995). They have observed that kids born to relatively heavier does and those which had heavier birth weight among the multiple born kids had a better chance of survival. Other researchers (Notter *et al*., 1991) also reported that weight is greatly influenced by the production system, lamb sex, ewe effect and ewe and season interaction.

2.7.3 Carcass characteristics and fatty acids composition of sheep meat

Before we attempt to optimize approaches towards lean lamb production, it is essential to understand environmental and genetic factors influencing the lean: fat ratio. Characterization of breeds according to carcass composition is one such method through which potential genetic resources for lean lamb production could be identified. Such characterizations lead to a better understanding of management alternatives required for different genotypes. The existence of genetic variation among breeds accordingly growth and carcass characteristics have been described by Dickerson *et al.* (1972) and by Crouse et *al.* (1981).

Table 2: Carcass tissue proportions for various temperate and tropical sheep breeds and crosses

Breed/Breed cross	**Age**	**Carcass composition (%)**				**Source**
		Lean	**Fat**	**Bone**	**Rest**	
Awassi	9	55.3	19.5	25.2	na	Gaili and El- Najem 1992
Najdi	9	54.3	20.3	25.4	na	Ibid
Baluchi	6.5	75.9	6.7	17.1	na	Farid 1991
Border Leicester	na	56.1	25.4	na	na	Kempster et al.1986
Hampshire Down	na	54.6	27.7	na	na	Kempster et al.1986
Ile de France	5	55.8	26.3	16.4	na	Wolf et al.1980
Merino	na	55.7	24.1	15.7	na	Teixeria and Delfa 1994
Oxford Down	5	56.3	24.6	17.5	na	Wolf et al.1980
Sudan Desert	na	57.3	19.0	21.0	na	Khalafalla and ElKhidir 1985
Suffolk	na	55.5	23.8	16.0	na	Teixeria and Delfa 1994
Texel	5	60.5	21.5	16.	na	Wolf et al.1980

na = not available

In the same context of observations on some seven British breeds, Taylor et *al.* (1989) have concluded that as breed size increased, the proportion of carcass muscle and bone did decrease. It was also observed that the breeds not only did differ in the proportions of carcass muscle, fat and bone but also maintain their distributions. Gaili (1979) and Gatenby (1986) reported that tropical sheep tend to deposit more intramuscular and internal fat and less subcutaneous fat compared to temperate mutton breeds. Evidence exists that tropical and temperate breeds generally do not differ in their carcass composition (Gatenby, 1986). However according to the author, tropical and temperate breeds do differ in size and distribution of fat deposited in the body.

In meat production enterprises, lean is the most important economic component of the carcass. Producing and marketing of lean lamb to meet consumer demands for low fat has become a challenge for the livestock industry particularly in developed countries. As stated by Farid (1991), the relative merit of different sheep breeds for meat production is determined by a high proportion of lean, and a low proportion of fat and bone in the carcass. According to Taylor *et al.* (1989) the respective characteristics of superior carcasses are: a high proportion of muscle (lean), a low proportion of bone and an optimal level of fat cover. According to the authors, the proportions are in turn influenced by the stage of maturity or mature size of the animal. Due to a strong breed influence on body composition (Taylor *et al*., 1989) Better opportunities do exist to select among breeds for differences in these traits even at a similar maturity level in body weights.

As reported by Berg and Walters (1983), the proportion of muscle (lean) in a carcass varies indirectly with the fat proportion, whereby a higher fat proportion is associated with a lower proportion of muscle and vice versa. The authors suggested the lean to live weight ratio as a valuable index of yield, since genetic difference appear to be of major importance.

Tissue growth patterns and the resulting changes in the chemical composition of the body are very much influenced by many interrelated environmental as well as genetic factors (Orr, 1982). According to this author, animals of the same species mostly vary in their mature body size and weight which is also reflected in differences of their carcass composition. The other most important factors that are known to influence carcass composition are sex and feed. In a study undertaken by Canton *et al*. (1992) it was observed that the nutritional level is related to carcass yield, carcass quality and fat tissue development and composition.

Banskalieva (1996) noted that fat is made of several substances, one of them is glycerol, the others are known under the name of fatty acids. Although there are several fatty acids, 3 of them are found in greater quantities which are the steric acid (C18:0), palmitic acid (C16:0) and oleic acid (C18:1). The steric and palmitic acids tend to form a solid fat at the normal temperature and the oleic acids tends to form an oily fat at normal temperature reducing the palatability of the ration (Atti *et al*., 2000). For these reasons, these authors conclude it is necessary to avoid its use with certain oily food like corn and combined with products of palm trees and others. Banskalieva (1996) added that the quality of sheepmeat depends not only on its content of fat deposit but also on the proportion of saturated fatty acids / unsaturated fatty acids. These two parameters vary according to the race, the age, the food and the site of deposit of the fat (sub cutaneous, caudal and renals....) of sheep.

Mehran and Filsoof (2006) examined the fatty acids composition of the fat tail of 5 breeds of sheep. They noted that the fatty acids composition varies from breed to breed, but 15 major fatty acids were identified in measurable quantity in all breeds. These are myristic (2.4-5.5%), pentadecanoic (0.6-1.0%), palmitic (18.2-23.6%), heptadecanoic (0.9-2.3%), stearic (7.1-22.1%) and arachidic (0.1-0.3%) acids. Myristoleic (0.3-2.1%), palmitoleic (1.4-3.6%), oleic (39.6-53.5%), linoleic (2.1-3.7%) and linolenic (2.2-2.9%) acids were the main unsaturated fatty acids.

According to Jonsdottir *et al.* (2001) the fatty acid composition of sheep meat varies according to weight, sex, age and diet. In general, with increased weight the total proportion of saturated fatty acids and polyunsaturated fatty acids decrease, while the total proportion of monounsaturated fatty acids increases. The main difference between the fatty acid composition of subcutaneous fat in lambs, ewes and rams was a higher concentration of C18:0 in ewes, compared to lambs and rams, but a lower concentration of C18:1. Lambs contained more of C10:0 and particularly C12:0 and C14:0 fatty acids that presumably derived from the milk. The intramuscular fat of lambs had a higher content of long chain polyunsaturated fatty acids and higher content of saturated fatty acids that originates from milk (C12:0, C14:0 and C10:0) compared to ewes and rams. The concentrations of C16:0 and C18:0 were higher in ewes compared to lambs. The effect of diet on the fatty acid content of meat can be summarized as follows: a lower content of the saturated fats C10:0, C12:0 and C14:0, both in subcutaneous and intramuscular fat, can be obtained by weaning. Fodder which is rich in energy will result in heavier carcasses and will bring about a decrease in the content of monounsaturated fatty acids will increase. There is an especially marked change in the ratio C18:0/ C18:1, particularly in subcutaneous fat. Energy rich fodder also results in more fat and a relatively lower content of polyunsaturated fatty acids.

2.7.4 Reproductive performance of Awassi sheep

The duration of pregnancy varies from 145 -152 days (average 149.2 days), with lambing reported taking place primarily from December (30 %) through January (52.9 %) and February (10.7%) (Choueiri *et al.*1966). In mountainous regions (mostly in the Bekaa valley where elevation is higher than 800 m) the lambing season is delayed and concentrated in February and March, avoiding the cold weather.

The Awassi is not considered a prolific breed. According to farmers, about 85 – 90 % of pregnant sheep give birth to a single lamb, however, the percentage of twins can reach 10 -15 % in good years. Most surveys show that lambing percentages are low in flocks in west Asia including Lebanon (Treacher *et al*., 1994).

According to Awassi sheep surveys conducted by ICARDA (1993) and Hamadeh *et al.* (1997), under extensive system of production in the Bekaa valley, the number of lambs born per dam varied from 69 % to 95 % and the number of lamb weaned was even lower, varying from 60% to 88 %.

According to Srour *et al.* 2006, fertility and prolificacy of Awassi ewes were respectively 0.94 and 1.28 and the age at puberty was reached at 7 months of age.

2.7.5 Milk production

Milk production of Awassi sheep in extensive to semi - extensive systems of production varies from 50 to 250 Kg; the highest production is reported to occur in the spring. Farmers say that lactation duration is 100 -180 days. Milk production data (911 lactations) collected by Choueiri *et al.* (1966) and Gûrsoy (1992) on the performance of Awassi sheep showed that average milk production was 222 Kg and maximum yield 406 Kg. Duration of lactation varied from 179 to 217 days. Srour *et al.* (2006) estimated that average milk production in Lebanon is 112 kg / lactation and varied between production systems from 30 to 170 kg. The average fat and protein content were respectively 6.9 and 5.4%. In a more recent survey on Awassi sheep production under extensive systems in the Bekaa valley, milk production levels were reported to be as low as 37.1 – 55.2 Kg / head/ season for a lactation period of 102 - 115 days (mean 110 days) (Hamadeh *et al.*, 1996). These levels do not include the suckling period when milk is left for lambs.

According to Galal *et al.* (EAAP, 2006), Awassi is the most widespread sheep breed of non–european region. The breed is well adapted to a wide rang of environmental conditions from the steppe to the highly intensive system. Performance of the breed varies according to production environment and strain, the Israeli improved awassi being the haviest and producing the highest amount of milk. Efforts to genetically improve milk production yielded positive results. In Israel the phenotypic average of lactation milk production increased from 297 Kg in the 1940's to over 500 Kg in the 1990's, while in syria a selection program succeeded to increase it by 13% in eight years. In Turkey, the mean milked yield of ewes increased from 67 to 152 Kg in a selection program that lasted for seven years.

2.8 Systematic factors affecting performance traits

Like all quantitative traits, reproduction is affected by both genetic and environmental (non genetic) factors.

2.8.1 Genetic make up

Annual Reproductive performances of some sheep breeds in terms of lams born per lambing ewe are given in table 3.

Table 3: Reproductive performances of some sheep breeds in Middle Eastern areas

Breed	Lambs born / 100 lambing ewes/ year
Anatolian Merino	118
Awassi	115 – 117
Chios	161 – 227
East Friesian	200
Finnish Landrace	156 – 227
Merino	115 – 163
Hampshire	160
Rambouillet	110 – 161
Romanov	208 – 242

(Sonmez and Kaymakci, 1987).

Inter – breed differences are significant; Finnish Landrace, Chios, Romanov, East Friesian breeds are some of the well known prolific breeds (Sonmez and Kamakci 1987; Owen 1988).

The Awassi sheep is generally considered a non prolific breed. One of the valid theories about the low prolificacy of Awassi argues that Awassi have been selected for high milk yield and size while reproductive efficiency has been neglected. Favoring rams of larger size also created bias against twin – born, slow growing lambs (Epstein, 1985). Another view emphasizes the preferences of producers for single – born thrifty lambs because of the insufficient level of nutrients provided by the meager conditions that causes high lamb mortality in multiple births (Oczan, 1990).

2.8.2 Environmental factors

Many environmental factors are known to govern reproductive performance of Awassi sheep. Determining the magnitude of their effects is very important because subsequent improvements are expected to be more pronounced and achieved in a short period.

Age of ewe: it has been clearly shown that the age of the ewe affects twinning to a great extent. The twinning rate biologically increases up the forth and fifth lambing and then declines gradually. Precocity is an important source of increasing returns from sheep but it depends on factors such as breed, weight, nutrition and management of the lambs. The early maturing breeds can have precocious lambing at the age of first lamb age and therefore are mated at the age of 7 – 8 months when they reach 60 – 70 % of their mature size. Awassi lambs have been shown to have subsequent successful precocious lambing (Gursoy, 1992). This is a potential cost a minimizing practice because it cuts almost one full year of costs and provides appreciable income for the sales of lamb and milk. In fact, it requires at least semi – intensive to intensive management for lambs to reach at least 35 – 40 kg before mating. Under poorer management the lifetime production of a yearling will be affected throughout.

Level of nutrition: In general, a low plan of nutrition adversely affects the reproductive performance of sheep. The effects are primarily seen in lambs reaching sexual maturity, in the estrus activity of the mature ewe, the number of ova shed, the fertilization and implantation of ova (conception), the viability of embryo and fetus as well as the lamb survival after birth (Economides, 1986).

Body Weight of ewe: close relation exists between the weight of a ewe and its reproductive performance. In other words, as the live weight of a ewes increases, the number of lambs born per ewe increases accordingly (Gursoy, 1992).

2.8.3 Growth and weight

2.8.3.1 Weight changes in Awassi sheep

Growth in animals is defined by an increase in number of body cells and by growth and differentiation in body cells (Bathaei and Leroy, 1996; Orr, 1982). The growth rate and body size along with changes in body composition of animals are of great economic importance for efficient production of meat animals. According to Bathaei and Leroy (1996), animal growth can be expressed as the positive change in body weight per unit of time or by plotting body weight against age. In another study (Gatenby, 1986), it is suggested that growth in animals is mostly measured by an increase in body weight, leading to changes in body form and composition. As stated by Orr (1982), the increase in body mass of farm animals is primarily a reflection of the growth of carcass tissues consisting of lean, bone and fat.

According to Velez *et al.* (1993) animals though loose weight during the dry season where both quantity and quality of forage available are limited.

The first stage to improve productivity of a sheep flock therefore should focus on improving the feeding and reproductive management practices and providing better health services. Having done that, one could also plan for a long term genetic improvement through selection within the local flock or through crossbreeding or both. In order to bring such anticipated change, a better knowledge and understanding of the performance of the breeds is necessary.

In order to maximize the utilization of available breed resources, it is highly beneficial if the performance of animals is tested within the prevailing production system (Peters, 1989; Lahlou – Kassi, 1987). Such investigation may not reflect the true genetic potential of the animals studied. Peters (1989) reported that, it will be essential to study the animals under a controlled environment in order to quantify their genetic performance ability. On the other hand, livestock performance under a prevailing more fluctuating production environment could indicate prospects for improved productivity, generate management variables, identify production constraints and areas for improvement. Since small ruminants have to compete with other livestock species for available feed resources, their production performance will have to be as efficient as possible (Peters, 1989).

Throughout the production cycle, sheep producers must know whether or not their sheep are in condition (too thin, too fat, or just right) for respective stages of production: breeding, late pregnancy, lactation.

Weight at a given stage of production is the best indicator, but because a wide variation in mature sizes between individuals and breeds exist, it is extremely difficult to use weight as simple parameters to determine proper condition. Body condition scoring describes the condition of a sheep approximately, it is convenient, and is much more accurate than a simple eye appraisal.

Body condition score estimates the condition of muscling and fat development. Scoring is based on feeling the level of muscling and fat of deposition over and around the vertebrae in the loin region . In addition to the central spinal column, loin vertebrae have a vertical bone protrusion (spinous process) and a short horizontal protrusion on each side (transverse process). Both of these protrusions are felt and used to assess an individual body condition score (Thompson *et al*., 2003).

A body condition score of 3 versus 3.5 does not present a real difference, but a relative difference between a 2.5 and a 4 certainly is of concern. On average, a difference of one unit of condition score is equivalent to about 13 percent of the live weight of a ewe at a moderate (3 - 3.5) body condition score. Body condition scoring being a subjective way to evaluate the status of a sheep flock, neverless is a potential tool for producers to increase the production efficiency at their flocks.

2.8.4 Fat reserves

2.8.4.1 Effects of age and weight

At birth, lamb sheep contain little fat, but as the weight of the carcass increases, the quantity of fat increases (Owen, 1976). In the same context, Berg and Walters (1983) added that fat deposition is believed to start out relatively slowly and increases geometrically as the animal enters a fattening phase. Bocquier *et al.* (1988) showed that when the lamb increases in weight, its body composition and carcass change; the proportion of bone tissues and muscles decreases whereas that of fat increases strongly. Goodwin (1971) showed that the fat tissues are the last to develop and are the more severely affected by the feed ration. Owen (1976) added that the quite reduced fatty tail of animal at birth is determined genetically. In lambs and hoggets, the proportion of essential parts of the body like head, legs, bones and internal body is large; the proportion of the muscles and fat is in contrast low. The muscular fabrics increase more quickly than the essential parts and fat is the last to evolve and the most severely affected by the feed ration. This assumption is also supported by Rashid *et al.* (1986) who observed that when the weight of the carcass increases by 30 to 45 kg, the proportion of meat and bone decreases by 57.8 to 47.5 % while fat increases by 14.8 to 29.3 %. In the same context, Zamiri and Izadifard (1997) showed that multiparous Awassi sheep have a fat tail and consequently fat deposits more significant than in primiparous animals. On this side, Atti (1991) established highly significant correlations ($p<0.01$) between the animal weight and various tail measurements (volume, length and circumference).

Bocquier *et al.* (1988) showed that the birth weight could have effects on the accumulation of carcass fat level. Sanz *et al.* (2006) showed that the lightest lamb at birth showed the highest pelvic-renal fat percentage and the lowest mesenteric one ($p<0.001$), compared to heavy weight lambs.

As for fat mobilization in periods of feed starvation, Burton *et al.* (1972) showed that this mobilization is a function on animals maturity and its adiposity; the mobilization is more intense in adult rams than in young lambs and in fatty animals that in thin ones.

With regard to the balance between saturated and unsaturated fatty acids, Banskalieva (1996) showed a tendency towards unsaturated fats on the level of various fat deposits, with increases in the rates of oleic acid (C18:1) and linoleic (C18:2) at the expense of palmitic acid (C16:0) in adult and fatty animals. However, the quality of the fat is related to its site of accumulation; thus the suprarenal fat deposits are richer in saturated fatty acids than those under cutaneous.

2.8.4.2 Effects of sex and physiological state of the animals

Bocquier *et al.* (1988) showed that at the same weight females are fattier than the males and produce carcasses which contain a stronger concentration of fat.

In their survey on Serrana kids, Rodrigues et *al.* (2006) tried to evaluate the effect of sex and carcass weight on the carcass composition of kids. They found that female kids showed a higher intramuscular fat proportion ($p<0.05$), a muscle/bone ratio and KKCF (kidney, knob and channel fat) than males. However, male kids had a higher bone proportion and muscle/fat ratio. All fat depots increased and the bone proportion decreased ($p<0.05$) with an increase in carcass weight. The increase in carcass weight induced an increase in the muscle/bone ratio ($p<0.05$) and a decrease in the muscle/fat ratio ($p<0.05$).

Banskalieva (1996) showed that the content of lipids in ram lambs contained greater quantities of unsaturated fatty acids than those of ewes. He noted that castration had no detectable effect on the fatty acid composition of the perirenal adipose tissue of lambs.

In addition, Zamiri and Izadifard (1997) noted that the fatty tail of Awassi ewes is larger before lambing and loses weight during the first month of lactation. Abi Saab *et al.* (1999) related this to the fact that lambing in Lebanon takes place in January, when the pastures are not green. The females which nurse are usually underfed and the fatty tail narrows. A contribution of supplement feed in this case can be beneficial. On their side, Bocquier *et al.* (1988) showed that the increase in live weight of females, observed during the final phase of pregnancy and composed of fetal development and its appendices, is accompanied by a reduction in body weight and body reserves under unfavorable feeding conditions. These reserves remain stable or decrease only slightly in favorable areas where the requirements for gestation of a ewe are met by the ration. These authors added that the energy needs are also high during lactation; the ewes then use their body reserves, primarily made up of fat and very few proteins.

2.8.4.3 Effects of nutrition

Gatenby (1986) noted that fat is deposited only if surplus of nutrients are available. According to him, the higher the level of nutrition or the lower the growth capacity, the more fat is deposited in lambs at any given age and body weight.

Abi Saab *et al.* (1999) showed that nutrition is one of the factors that influence more the deposit of fat, since with nutrition rich in concentrates and energy a share of this energy would be used by tissues and body cells to improve growth and development; the part which remain will be used for the deposit of fat. Goodwin

(1971) mentioned that the greatest loss at the time of feed restriction is that of stored fat. Whereas if concentrates exist, they lead to formation and deposit of fat content (Miller *et al.*, 1986; Banskalieva *et al.* , 1994; Webb *et al.* , 1994). Nelson (1964) observed that the fat reserves accumulate under the skin and in and around the various organs of the body and decrease in periods of underfeeding and vice versa. According to Alkass *et al.* (1985), sheep nourished with 2% of concentrate develop fat more quickly than those fed with 1% concentrate.

A recent study conducted by Sepheri et *al.* (2006) on Mogani lambs, that were maintained on varying levels of protein supplementation in addition to free grazing showed that average daily weight gain, slaughter weight, warm dressing percentage, kidney fat, pelvic fat, abdominal fat and fat tail weight were significantly increased ($p<0.005$) by increased levels of crude proteins.

Petrova *et al.* (1994) showed that the contribution of supplements not only affects the quantity of fat deposited but also its quality, with an increase in unsaturated fatty acids in rams subjected to a ration with high energy value.

A study on South African Merino sheep (Cronje and Weites, 1990) has shown that carcass composition, expressed as a proportion of carcass weight, was found to be highly influenced by maize supplementation. They observed that the proportion of fat was doubled with 200 g allowance per day compared to the control.

Following a study made on Awassi sheep in different Mohafazats from Lebanon, Abi Saab *et al.* (1999) showed that the accumulation of fat in the tail of the Awassi sheep subjected to an extensive breeding depends on morphological and geographical characteristics on each area (plains or terraces) and the availability and feed value of the pastures. Like consequence, the raised sheep at Bekaa have a fatty tail larger than those in Mount-Lebanon. At Mount-Lebanon, the pastures are presented in the form of laminated spaces and are degraded in their great part. Consequently, the sheep will be led to consume much energy in research of nutrients, which results in a tail which is developed little and does not accumulate fat. While in Bekaa, the plains are extremely available, the sheep do not have to consume any more much energy at the time of a grazing ground where fodder have not only significant qualities and quantities but also a high nutritive diversity.

According to Gatenby (1986) the supply of nutrients in the tropics and subtropical countries is not constant both in quantity and quality leading to seasonal variation in growth-rate of the animals.

In intensive livestock production systems where milk and meat are the main production objectives, feed costs account as a major component of the expenses.

Efficiency of feed utilization is an important trait in meat production enterprises (Terril and Maijala, 1991) and should be included in selection programs for genetic improvement of animal performance (Parker *et al.*, 1991). However, it has always been difficult to improve feed resources particularly in dry areas.

In Middle Eastern countries, the main source of livestock feed is grazing on natural pasture which mostly suffers from seasonal variations both in quality and quantity. This is considered to be the most important constraint to livestock production and reproduction in traditional systems where the low economic input to the system is evident. Black (1990) has reported that feed intake is closely correlated with both the amount of pasture available per animal per day and the digestibility of the forage selected. Another review by Said and Tolera (1993) shows that plant cell-wall is the major restrictive determinant of feed intake. However, the authors also indicated that the actual feed intake of an animal depends on its genotype and physiological state, the quality and the quantity of the feed available during grazing. In an earlier study, Arnold and Birrel (1977) have reported that herbage intake of grazing sheep is influenced by age, size, weight and physiological state of the animal, climatic conditions and the availability and quality of feed.

Kabbali *et al.* (1992) have concluded that weight loss of lambs during feed shortages results in the loss of weight in internal organs and such lambs recover the lost weight during re-feeding through compensatory growth resulting in better feed efficiency and leaner carcasses.

Priolo *et al.* (2006) studied the effect of feed scarcity on meat quality of lambs. They found that under nutrition reduces meat fat content due to higher mobilization of body fat stores compared to meat of well-nourished ruminants. Moreover, the negative metabolic energy balance in underfed animals causes high meat ultimate pH values, producing detrimental effect on meat quality attribute. The exploitation of bushes and browses in natural rangelands and of agro-industrial by-products is an effective solution to overcome feed scarcity. Some of these feedstuffs contain secondary compounds, as condensed tannins, resulting in meat lighter in color compared to meat of animals offered tannin-free resources. Special attention should be given to shrubs (Cactus, Opuntia ficus indica), trees (e.g. Argan fruit pulp and leaves) or forbs (e.g. Salicornia bigelovii) that seem to increase intramuscular fat content of conjugated linoleic acid (CLA) and polyunsaturated fatty acids (PUFA), which are beneficial to human health. Meat flavor is variously affected by animal nutritional condition and diet, depending on the accumulation of odor-active compounds which are transferred from feed into animal tissues or which are originated by animal metabolism.

Burton *et al.* (1992) showed that both protein and fat were mobilized during weight loss, but protein was lost at a slower rate, whereas fat was mobilized more rapidly than they were deposited during normal growth. Kabbali *et al.* (1992) showed that an adequate protein supply increase protein deposition at the expenses of fat reserves when animals are in negative energy balance. The body protein was conserved in energy-restricted lambs and lost in protein-restricted lambs. Fat mobilization was at similar rate for both energy and protein restricted lambs.

2.9 Importance of fat tail in Awassi sheep

For Awassi sheep, the fat is the principal reserve of energy. During the dry period, the animals accumulate their fatty reserves during the summer and use them at winter when food is rare (Banskalieva, 1996).

The majority of fatty tailed sheep are localised in the arid or semi arid areas where there is a deficit of feed resources (Shelton, 1987). Their characteristic consists in their preferential site of deposit of fat which is the tail, the internal quantity of fat is thus less significant than that with thin tail (Atti, 1991). He described the fatty tail like a large bilobate broad cushion, deprived of wool on the lower face. This tail is suspended until above the bulges, the part of the medium is narrower, wool glaze and upwards folded. This tail generally broader in the male than in the female weighs 4 to 5 kg and, in the well nourished animals, it can weigh up to 6 kg (females) or 10 kg (male).

Most of the sheep breeds are fat tailed. Large fat tail also interfere with mating and may reduce fertility. Some fat tails are so large that they almost touch the ground, and thus interfere with normal locomotion of tha animal(Zamiri and Izadifard, 1997).

Gatenby (1991) added that the sheep which must survive of long dry seasons often have a fat tail or fatty rump equivalent to the rump of the camel. Bicer *et al.* (1992) considered that the fat deposited in the tail is a source of energy for the animals for the periods of low consumption of energy. Zamiri and Izadifard (1997) added that in the nomadic flocks nomadic flocks the fat tail serves as a source of energy during migratory periods when pasture is scarce.

Several studies indicated that docking fat-tailed lambs initially reduces growth but that post-weaning growth and feed conversion efficiency then subsequently increase. The amount of fat deposited, the total separable lean meat to fat ratio and the meat quality all increase, while the percentage of bone in the carcases either decreases or remains unchanged. Wool growth and characteristics are, in general, not affected and reproductive traits in ewes and lambs are improved by docking. The rectal temperature, respiration rate and pulse rate are decreased following docking. The concentrations of immunoreactive beta-endorphin and cortisol in the plasma and the incidence of foot stamping and restlessness, as indicators of stress, increase after docking. Other constituents of the blood are not significantly altered following docking or by the methods used for docking. Docking of fat-tailed sheep using rubber rings at one day of age can be recommended (Bicer *et al.*, 1992; Zamiri and Izadifard, 1997; Farid, 1990).

2.10 Interaction between nutrition, fat reserves and fertility of the ewes

Treacher and Filo (1987) showed that the lambing percentage of Awassi ewes raised in the Middle East are rarely above 85 % and are often as low as 60 %. This is a major cause of the low output of sheep systems in the region. Low fertility results from a combination of poor nutrition and management, disease and possibly, the effects of high temperatures at mating, which generally occurs in mid summer.

Economides (1995) mentioned that the reproductive capacities of the Awassi sheep can be improved by providing the females with a balanced feed ration before and during the mating season and the last weeks of pregnancy.

On their side, Landeau and Molle (1987) showed that the fertility and the release of the sexual activity (activity of estrus and ovulation) during the sexual season can be improved by a contribution of supplements before reproduction. According to these authors, the nutrition affects the reproductive efficiency of females. i.e., estrus activity, ovulation and embryo survival. Nutrition affects reproduction through short (< 10 days, i.e. “immediate nutrient effect”), and along term effects (“static, i.e. mediated through body condition; static and dynamic, i.e., confounded effects of body condition and body weight gain). Landeau and Molle (1987) added that the body condition affects the onset of anoestrus, the resumption of post-weaning estrus if photoperiod is favorable, and ovulation rate. The positive effect of flushing i.e. supply of energy and protein in excess of requirements for body maintenance, on ovulation rate, is mediated, at least partly, through glucose, amino acid and insulin metabolism. Provision of excess dietary protein during a few days prior to mating is a potential way to improve fecundity, but effects vary according to source of protein. On its side, Brink (1990) added that an acute deficit of energy, and over fattening of ewes, reduce progesterone concentration in blood and embryo survival during the first stages of pregnancy. Therefore flushing must be limited to the pre –mating period, which implies synchronization of estrus.

In the same context, Thomson and Bahhady (1988) established a strong correlation between the fertility of the Awassi sheep and body weight at the time of mating, observing a fertility rate of 100% if females weighing more than 50 kg.

Also, Kassem *et al.* (1989) found an increase in lambing percentage of 0.3 to 1.3 for each kg increase in body weight before mating. In the same context, Smith (1985) observed that each kg weight increase at mating produced an increase of 2 % in ovulation rate. Similar results were obtained by Molina *et al.* (1994) at the Manchega race, from the highly significant correlations ($p<0.01$) were obtained between the body Condition Score (BCS) and the fertility on part and between the body weight and the prolificacy on the other part.

Generally, the better the body condition score at mating, the higher the ovulation rate and therefore the higher the potential lambing percentage. However, ewes with a condition score greater than 4 at breeding tend to have a higher incidence of barrenness. Ewes with a condition score less than 3 at breeding will be more responsive to the effects of flushing than those with condition scores at 3.0-3.5 at mating. Ewe body condition score at lambing had an effect on total weight of lambs weaned per ewe. Ewes with a body condition score of 3 to 4 at lambing lost fewer offspring and weaned heavier lambs than those with a condition score of 2.5 or less. Some suggested (optimum) condition score values for the various stages of the production cycle are illustrated in table 4.

In addition, according to Abi Saab *et al.* (1999) the body growth has a positive and highly significant correlation with various caudal measurements (circumference and volume, $p<0.01$). However, according to Zamiri and Izadifard (1997) the presence of well developed fatty tails can involve a reduction of the fertility because large fat tail interferes with mating. It thus appears necessary to develop a practice of breeding not supporting the excessive development of the fatty tail, while maintaining a good body condition.

Table 4: Various condition score values for the various stage of the production cycle

Production	Optimum stage score
Breeding	3 – 4
Early – Mid Gestation	2.5 – 4
Lambing	3
(singles)	3.0 – 3.5
(twins)	3.5 – 4
Weaning	2 or higher.

Lason and Mantecon (1993) have reported that food restriction followed by compensatory growth delays growth and maturation of animals thereby affecting carcass composition. However, since body fat is mobilized to provide nutrients for body maintenance during periods of limitations in food intake, the performance of animals during and after a period of food restriction is likely to be affected (Afonson and Thompson, 1996).

Considering the complexity of the relation between nutrition, adiposity and fertility of Awassi sheep especially in traditional breeding where the food availability is subjected to seasonal variations having permanent effects on the fertility and the profitability of the herds; the update of a system of improved breeding is essential. The establishment of such a system in the Awassi sheep requires the development of the relations which link the body condition score, the body growth and that tail according to the various physiological stages of female (heat, gestation, parturition and lactation) and the nutritional level offered by the Lebanese pastures, these problems are the objects of this experiment.

3 MATERIAL AND METHODS

Two experiments were conducted in order to evaluate the relationship between reproductive performance and body condition score of Awassi ewes under different management system and different agro-ecological regions of Lebanon.

3.1 First experiment

3.1.1 Experimental location and climate

The first experiment was undertaken one month before mating, during the mating season and then until weaning in a traditional breeding flock (around 100 hectares of grazing land), in a mountainous region of the Bekaa valley in Lebanon, about 100 km east of Beirut, and 30 km of Syria; The altitude is about 1250 m above sea level. The weather is very cold in winter (-5˚C) with abundant snow covering the soil and night frost and very hot in summer (up to 35˚C). The lowest temperature was reported to be -7˚C during january and the highest one 40˚C during August.

The rainfall pattern is characterised as annual. The average annual rainfall recorded between 1990 - 2003 was 700 mm. More than 80 % of the average annual rainfall is always recorded during the rainy season (November to beginning of April) with night frosts occuring from December to March. The small rains occur during end of September to end of October and April to end of May. The dry period is from June to September.

3.1.2 Composition of pasture

The quantitative and qualitative evaluation of intake in natural pasture is a challenging task, because methods based on the study state principles are not relevant. This is due to diet variability from day to day because sheep select green leaves and grains first, while stems and shrubs were consumed mainly once the more nutritionnal components of rangelands are depleted.

Feed intake by sheep can be calculated by using the Pening and Hooper (1985) procedure which is based on weighing sheep before and after grazing with an allowance for insensible weight loss (IWL). Sheep were fit with harnesses in which feces and urine were collected in disposable diappers.This measurement was done once monthly on each selected groups during the grazing period (from June till

October). The average daily weight intake was calculated using the following formula:

AFI= (W2-W1)+IWL

Where:

AFI= average feed intake per head

W2= Weight before grazing

W1= weight after grazing

IWL = Insensible weight loss (feces and urine).

For the assessment of the qualitative value of the pasture. The types of plants present in different grazing areas were noted, and recorded by walking along with the shepherd and the flock.

General percentages that were determined were based upon the density and availability of each existing plant in the grazing area, and upon how frequenlty these plants were consumed by sheep. Based on these observations, samples of forages were collected to estimate the nutritionnal value of the diet. This information was noted every month during the summer and fall period because of the continuous change of the pasture due to grazing, climatic and other factors.

The colected samples were transferred to the laboratory , where they were stored in scaled plasic bags in a freezer at -20˚C. The foliage were cut with scissors into smaller pieces, mixed and weighed. The samples were dried in a Precision Scientific oven at 100˚C for 16 hours or overnight at a pressure of 15 psi. The dried foliage samples were weighed for moisture content determination. The dried foliage samples were subjected to fine grinding using Cuclotech grinding machine. The ground samples were stored in tightly closed plastic jar for latter analyses.

Moisture, ether extract, crude fiber, crude protein, ash, calcium and phosphorous were conducted on the collected samples according to the standard procedures recommended in the Official Methods of Analysis of AOAC 1980 (Kenneth, 1980). Neutral and Acid Detergent Fiber (NDF_ADF) were determined using the methods of Goering and Van Soest (1970).

3.1.3 Experimental sheep breed and their management

Eighty two Awassi sheep native from Lebanon were used in the first experiment with a stocking density of 3 heads per hectare, divided into 24 primiparous, 24 multiparous, 24 hoggets and 10 rams. The mature body weight of Awassi ewes is estimated to be between 45-65 kg while the mean body weight of ram ranged between 75-90 kg.

Experimented animals were separeted in a hogget and a adult herd until september.

The heat detection took place between mid July until mid August and the mating between August and September which corresponds to the first season of the reproduction period that extended from july till November. This period was divided into 4 week seasonal periods (P1- early phase / hot season (mid July - mid August), P2 - phase high season / mating season (mid August – mid September), P3 - phase of decline/ dry season (mid September - mid October), P4- late phase / rainfall season (mid October - mid November).

The lambing took place between end of December and mid of February, the lamb were weaned at age of 3 to 4 months. This period corresponds to the second season of the reproductive cycle of Awassi ewe. Fertility and prolificacy, survival rate and growth rate of new birth were recorded.

3.1.4 Experimental design and data collection for the first experiment

The study was designed as a three x two factorial experiment with age, body weight within age group and management level as factors. These factors constitued the following elements:

3 age groups of 24 females: hoggets (H) (< 1 year)
primiparous (P) (1-2 year)
multiparous (M) (3-4 years)

2 body weight groups (small and large) within age group:
Hsw vs Hlw (16-20 Kg vs 21-25 Kg)
Psw vs Plw (30-35 Kg vs 36-45 Kg)
Msw vs Mlw (39-43 kg vs 45-50 Kg)

2 management groups: 1) natural rangelands without supplementation
2) natural rangelands with supplementation of 200 g barley and concentrate per day in addition to grazing during the four phases of the reproduction period.

Hoggets, primiparous and multiparous were identified by ear tags and age were determined by dentition method.

Table 5: Experimental design of Awassi ewes during the experiment according to age, body weight and management system.

Age	Hoggets (24)				Primiparous (24)				Multiparous (24)			
Body weight	sw (12)		lw(12)		sw (12)		lw (12)		sw (12)		lw (12)	
management	TR	IM	TR	IM	TR	IM	TR	IM	TR	IM	TR	IM
No of animal	6	6	6	6	6	6	6	6	6	6	6	6

sw: small weight; lw: large weight; TR: traditionnal system; IM: improved system

Table 6: Distribution of Awassi ewes during the expeiment according to age, body weight and management system.

Breed	Age	Body weight	Management system	
			Traditional	Improved
Awassi ewes	Hogget (H) < 1 year; n = 24	Hsw: 16 – 20 kg; n = 12	Hsw; n =6	Hsw^{+}; n =6
		Hlw: 21– 25 kg; n = 12	Hlw; n =6	Hlw^{+}; n =6
	Primiparous (P) 1 -2 year; n = 24	Psw: 30 – 35 kg; n = 12	Psw; n =6	Psw^{+}; n =6
		Psw: 36 – 45 kg; n = 12	Plw; n =6	Plw^{+}; n =6
	Multiparous (M) 3- 4 year; n =24	Msw: 39 – 43 kg; n = 12	Psw; n =6	Psw^{+}; n =6
		Mlw: 45 – 50 kg; n = 12	Plw; n =6	Plw^{+}; n =6

+: supplemented animals

3.1.5 Grazing and feeding management

Animal grazed natural pasture daily for about 13 hours a day, crossing a distance from 14 to 16 km. The hoggets are kept on range to the farm (fig. 1 and fig.2). The site of pasture is generally mountainous with slopes and terraces. Ewes and lamds were herded together until weaning. After weaning, female and male were separeted but grazed the same paddocks in a rotational grazing schedule.

Figure 1. Adult herd at the site of pasture.

Figure 2. Control of hoggets at the site of pasture.

3.1.5.1 Supplementary feeding and health care

Only the improved groups of the experiment were supplemented with barley in the evening. Barley was offered at the rate of 200g/head/day. They were also provided with mineral and water adlibitum.

All flocks were routinely checked for any health problems and when animall fell sick, the identification of the animal, the date and cause of illness were registered by th veterinerian, so that the number of times the animal fell sick and the health category to be calculated.

Animals were drenched on regular basis against liver flukes and were vaccinated for pox, enterotoxemy, pasteurellosis and clostridial infection, and were sheared during June.

3.1.6 Performance data collection

This includes measurements of body weight, body measurements, tail measurements and body condition score.

3.1.6.1 Body weight and linear body measurements

Hoggets, primiparous and multiparous were weighed every week from P1 until P4 using scale with a precision of 0.1 kg metal balance . Lambs were weighed at birth and fortnightly thereafter until weaning at the age of 90 days.

The average daily weight gain (ADG) was calculated using the following formula

ADG = (W2-W1)*1000/A

Where:

ADG (g)= Average daily gain in gram

W1 kg = Birth weight or weight at the preceding age

W2 kg = weight at given age

A= age in days or days between weighing dates

Linear body measurements were taken together with weight measurements. All body measurements were taken with a measuring tape in centimetre and measured to the nearest 0.5 cm. The following linear body mesurements were taken:

- Body length : the distance between the crown and the sacrococcygeal joint.
- Body chest girth or heart girth: the circumference of the chest posterior to the forelegs at right angles to the body axis.

3.1.6.2 Tail measurements

Tail measurements were taken together with weight and linear body measurements every week during the experiment.

Using a measuring tape in centimetre and measured to the nearest 0.5 cm the following tail mesurements were taken:

- Tail length from the point of attachement to the tip.

- Tail circumference directly behind the tuber ichiad: due to the irregular shape of the fatty tail, the circumference was measured using ribbon measures in three places C_1, C_2 and C_3 representating the circumference of the fatty tail in its higher, mid and final part; average of the values forms the tail circumference (Abi Saab *& al.* , 1999)

- The tail volume was measured by the technique of water displacement. A ten liter plastic beaker was filled with water and was put in a bassin. The animal was held suspended by two people with its back facing the ground, allowing the tail loose. The animal was then lowered slowly until the tail has immersed completely into the water. The amount of water displaced from the beaker is then was collected from the bassin and measured by a graduated cylinder. The displaced water measured in liter is taken as the tail volume.

3.1.6.3 Body condition score of ewes

Body condition score was recorded at intervals of one week from phase P1 till phase P4 and thereafter monthly.

A safe and practical method for assessing an animal condition (i.e. determining whether the animal is too thin, too fat, or in the right condition for a particular purpose) is known as body condtion scoring. The accuracy of this method has been prooven with both thin – tailed as well as fat – tailed sheep.

The method is simple and consists of assessing the degree of fat and muscle deposition over the lumbar region of the animal's back – immediately behind the last rib and above the kidneys. As the animal gains weight it accumulates first muscle (firm tissue) and then fat over the bones in that area. In the extreme case, no bones can be distinguished and the tail appears fatty. When an animal becomes leaner and more emaciated, first fat and eventually muscle is lost and the tail is reduced to a baggy skin.The assessment is done by applying a slight pressure with the fingers on the area mentioned and assigning a score, that varies from 0 to 5, according to the degree of muscle and fat deposition.

How to locate the area to palpate and how to assign scores for assessing muscle and fat deposition?

In the lumbar region near the start of the tail, locate the vertebra or bone that has two horizontal or lateral bone “wings” (W) projecting to both sides of the main vertebra, parallell to the ground, and a spine bone (S) projecting upwards, perpendicular to the ground.

Palpate with your fingers to determine the amount of muscle and fat between the skin and over W and S. The ease with which the fingers pass under the end of these bones, and the filling of the eye (E) area with muscle between the parallell and perpendicular bones, gives a direct impression of the amount of fat and muscle (ICARDA, 2005).

This can be translated into the following score notes :

- note 0: the ewe is emaciated and near death. It is not possible to detect any muscular or fatty tissue between the skin and the bone.
- note 1: bone wings and spine bones feel sharp, the fingers pass easily under the ends, and the eye area is empty with no fat cover
- note 2: bone wings and spine bone still feel somewhat sharp, but smoother and more rounded. It is still possible to pass the fingers under the ends with a little pressure, and the the eye area is filled to a moderate depth with some fat cover.
- note 3: bone wings and spine bones are felt only as small elevations, it requires firm pressure to pass over the ends, and the eye area is filled with muscle (firm) anf has a moderate degree of fat cover (softer) .
- note 4: bone wings and spine bone can only be detected as hard line after pressing the eye muscle area, the ends of the bones cannot be felt, and the eye area is filled with muscle (firm) and has a thick covering of fat (soft).
- note 5: bone wings and spine bone cannot be detected, even with firm pressure. The ends cannot be distinguished either, and the eye area is filled with maximum fat cover. In addition, there is a large deposition of fat over the rump and tail .

Never allow lactating ewes or ewes in late pregnancy to go below a score of 3. You can also verify that ewes that do not produce lambs (barren ewes) usually have maximum scores (nearly 5).

3.1.7 Reproduction parameters

The reproduction parameters studied are heat detection, fertility and prolificacy.

3.1.7.1 Detection of heat

In order to determine the beginning of the reproduction period, the males were separated from the female flock. For detection of the first heat, teasers ram (males provided with aprons) (fig. 3) were introduced to the flock for a duration of one hour per day from the start of July until the peak of heat; the percentage of females detected in heat (by the act of immobilization) was recorded.

Figure 3. Detection of heat by introduction of a teaser ram within the female flock.

The fertility of the female was determined as percentage of lambing ewes.

The prolificacy was determined as the number of lambs born or litter size from 100 females. To facilitate the statistical analysis, a note of zero was given to non pregnant ewes and 1 for pregnant one. As for prolificacy a note of zero was given for no birth, 1 for single birht and 2 for twin birht. During the studies, the birth weight of lambs and their survival rate were also recorded until they were 3 months of age.

3.1.7.2 Pregnancy diagnosis

Pregnacy diagnosis was done by examining each ewe alone from 7 to 10 days post-conception by a veterinatian to determine the number of females get pregnant and if there was a case of abortion.

3.1.8 Methods of statistical analysis

The collected data of all measured growth parameters were subjected to 3 way ANOVA analysis where age, weight, and breeding system were considered as independent variables; the dependant variables included body weight, body chest girth, body length, tail length, tail volume and tail circumference. The interraction between the parameters were also reported. This variance analysis was done using Sigma stat (for Windows, release 3.1, 2000). In the same way, the effect of parameters on the reproductive performances were determined: Fertility rate was considered as binomial variable (0=open, 1= pregnant), while prolificacy was considered as trinomial variable (0= no birth, 1=single birth, 2=twin birth)

In order to test body condition score as indicator of body growth, adiposity of sheep meat and fat tail size, different correlation coefficients were established between BCS and all measured parameters using Sigma Stat programs.

The graphs were drawn using Excel (2003).

3.2 Second experiment

The aim of this experiment was to determine the relationship between body condition score, body weight, tail measurements and reproductive performance (fertility, prolificacy) at mating in the fat – tailed Awassi ewes under different climatic conditions, feeding and management conditions.

3.2.1 Experimental location and climate

The second experiment, completed during one year, was performed on 5 different flocks of Awassi sheep breed in five different agroecological zones of Lebanon; one flock from each region (Mount-Lebanon, Central Bekaa, Hermel, South-Lebanon, North-Lebanon). These regions differ in their altitude, temperature , humidity and pasture quality and defined as follow:

Zone 1: raised in the coastal region of Mount Lebanon (Baabda district) about 500 m above the sea level. This zone is characterised by a moderate weather (5˚C in winter and 30˚C in summer), high rainfall (800 mm), and moderate humidity (60% in winter and 70% in summer). Valleys are totally absent while foothill steppes and slopes are predominant. This region is highly urbanized; the grazing lands are poor with low quality pasture. Sheep are raised in small flocks sometimes mixed with goats. According to the Ministry of Agriculture (2005) at lebanon, the total number of sheep in this region was 14815 heads.

Zone 2: Akkar plain (Abde) from 50m altitude above the sea level is characterized by a moderate to hot weather (12˚C in winter and 32˚C in summer), moderate humidity (72% in winter and 77% in summer), the average annual rainfall was about 1097 mm. Sheep in this zone were mainly imported from Syria and raised by Bedouins. They are well-developped sheep due to the high quality pasture of these regions. According to the Ministry of Agriculture (2005) at lebanon, the total number of sheep in this zone was 22978 heads.

Zone 3: Bekaa (Terbol, Zahle district) from 900 m bove the sea level. This region provides the most fertile lands of Lebanon. The weather is semi arid with dry and hot summer (up to 40 ˚C) and cold winter (-7˚C) with abondant snow covering the soil. The average humidity was 78% in winter and 50% in summer. The average annual rainfall was 700 mm. According to the Ministry of Agriculture (2005) at lebanon, the total number of sheep in this zone was 46825 heads.

Zone 4: Raised in the Hermel region about 900 m above the sea level, near the north border of Syria . This region is characterized by a very arid weather, very hot in summer up to 45 ˚C and very cold winter (less than -2 ˚C), with low precipitation (425 mm), and humidity between 60% in winter and 40% in summer. According to the Ministry of Agriculture (2005) at lebanon, the total number of sheep in this zone was 15911 heads.

Zone 5: raised in the steppes of South-Lebanon (Benet Jbeil) about 600 m above the sea level. The average annual rainfall was 750 mm. The weather is moderately cold in winter (9˚C) and very hot in summer (35˚C), the average humidity was 70% during winter and 76% during summer.The foothill steppes of South-Lebanon are poor in vegetation being the prolongation of the Mount-Lebanon and Anti-Lebanon. The Israeli occupation of these lands for over 15 years had constituted an obstacle against the expansion of raising sheep in this region. Sheep raised in this region were subject to the same nutritionnal status as those in Mount-Lebanon. According to the Ministry of Agriculture (2005) at lebanon, the total number of sheep in this zone was 2079 heads.

3.2.2 Composition of pasture

The types of plants present in different grazing areas were recorded by walking along with the shepherd and the flock and were mainly distibuted as follows:

Most of the cultivated areas at Mount – Lebanon are covered by forest and pines.

The crop production in Central Bekaa includes agricultural crops (Wheat, barley, forages) and horticulture, while in Hermel it included agicultural crops such as wheat, barley.

The agricultural production in South and North Lebanon involves cropping (wheat, barley, forages) and horticulture such as fruit trees and vegetable crops.

Rangeland in these areas contribute to the whole animal diet (100%) from Marh till October.

3.2.3 Experimental sheep breed and their management

Experimented animals belongs to Awassi sheep native from Lebanon.

Flocks are submitted by ten volonteer breeder in order to evaluate the pasture quality and ameliorate the reproductive performance of Awassi ewe.

One flock from each zone were selected one week before the introduction of rams and 60 days after parturition, body condition scores were recorded for each individual ewes. At parturition, fertility and prolificacy were recorded.

Flock was composed of 88 mature Awassi ewes that is pimiaprous and multiparous ewes, hoggets and male were eliminated from the flock.

The mature body weight of Awassi ewes is estimated to be between 35-65 kg while the mean body weight of ram ranged between 75-90 kg.

The heat detection took place between mid July until mid August and the mating occurred between june and october which corresponded to the first season of the reproduction period that extended from july till November.

The lambing took place between November and April, the lambs were weaned between 3 to 4 months of age. Fertility and prolificacy, survival rate and growth rate of new birth were recorded.

3.2.4 Experimental design and data collection for the second experiment

The study was designed as a three x two factorial experiment with age, body weight within age group and management level as factors. These factors constitued the following elements:

2 age groups of ewes primiparous (P) (1-2 year)
multiparous (M) (3-4 years)

2 body weight groups (small and large) within age group:
Psw vs Plw (30-35 Kg vs 36-45 Kg)
Msw vs Mlw (39-43 kg vs 45-50 Kg)

2 management groups: 1) natural rangelands without supplementation
2) natural rangelands with supplementation of 0.5 kg concentrate per day in addition to grazing during the four phases of the reproduction period.

Primiparous and multiparous were identified by ear tags and age were determined by dentition method.

Table 7: Experimental design of Awassi ewes during the experiment according to age, body weight and management system in each flock of the 5 zones.

Age	Primiparous (44)				Multiparous (44)			
Body weight	sw (22)		lw (22)		SW(22)		LW(22)	
Management	TR	IM	TR	IM	TR	IM	TR	IM
No of animal	11	11	11	11	11	11	11	11

sw: small weight; lw: large weight; TR: traditionnal system; IM: improved system

Table 8: Distribution of Awassi ewes during the expeiment by age, body weight and management system in each flock of the 5 zones.

Breed	Age	Body weight	Management system	
			Traditional	Improved
Awassi ewes	Primiparous (P) 1 -2 year; n = 44	Psw: 30 – 35 kg; n = 22	Psw; n =11	Psw+; n =11
		Plw: 36 – 45 kg; n = 22	Plw; n =11	Plw+; n =11
	Multiparous (M) 3- 4 year; n = 44	Msw: 39 – 43 kg; n = 22	Msw; n =11	Msw+; n =11
		Plw: 45 – 50 kg; n = 22	Mlw; n =11	Mlw+; n =11

+: supplemented ewes

3.2.5 Grazing and feeding management

Animal grazed natural pasture daily for about 13 hours a day, crossing a distance from 12 to 16 km.The site of pasture is generally mountainous at Terbol, Benet jbeil and Baabda, plains at Abde and Hermel. Ewes and lamds were herded together until weaning. After weaning, female and male were separeted but grazed the same paddocks in a rotational grazing schedule.

3.2.5.1 Supplementary feeding and health care

As a result to foodshortage during winter season, sheep had been fed with about 0.5 kg per head of a balanced concentate contributing to mainly 95% of the diet. The concentrate was composed of Maize (25%), wheat graines (15%), barley graines (15%), wheat straw (40%), Sunflower seeds (5%) in addition to a premix of salt and vitamines.

All flocks were routinely checked for any health problems and when animall fell sick, the identification of the animal, the date and cause of illness were registered by the veterinerian, so that the number of times the animal fell sick and the health category to be calculated.

Animals were drenched on regular basis against liver flukes and were vaccinated for pox, enterotoxemy, pasteurellosis and clostridial infection, and were sheared during June.

3.2.6 Performance data collection

This includes measurements of body weight, tail measurements, body condition score.

3.2.6.1 Body weight measurements

Primiparous and multiparous were weighed a week before the introduction of rams and then each 10 days using scale with a precision of 0.1 kg metal balance until 60 days after parturition. Lambs were weighed at birth and fortnightly thereafter until weaning at the age of 60days.

3.2.6.2 Tail measurements

Tail measurements were taken together with weight and linear body measurements every week during the experiment.

Using a measuring tape in centimetre and measured to the nearest 0.5 cm the following tail mesurements were taken:

- Tail length from the point of attachement to the tip.
- Tail circumference directly behind the tuber ichiad: due to the irregular shape of the fatty tail, the circumference was measured using ribbon measures in three places C

$_{1,}$ C_2 and C_3 representating the circumference of the fatty tail in its higher, mid and final part; average of the values forms the tail circumference (Abi Saab *& al.* , 1999)

- The tail volume was measured by the technique of water displacement. A ten liter plastic beaker was filled with water and was put in a bassin. The animal was held suspended by two people with its back facing the ground, allowing the tail loose. The animal was then lowered slowly until the tail has immersed completely into the water. The amount of water displaced from the beaker is then was collected from the bassin and measured by a graduated cylinder. The displaced water measured in liter is taken as the tail volume.

3.2.6.3 Body condition score of ewes

Body condition score was recorded before one week of the introduction of rams graded on a 5 step –scales as applied in the first experiment.

3.2.7 Reproduction parameters

The reproduction parameters studied are heat detection, fertility and prolificacy.

In order to determine the beginning the detection of the first heat teasers ram were introduced into each flock for a duration of one hour per day from the start of July until the peak of heat; the percentage of females detected in heat (by the act of immobilization) was recorded.

The fertility of the female was determined as percentage of parturition within each group of ewes. The prolificacy of the females was determined as the number of lambs born from 100 females. A note of zero was given to non pregnant ewes and 1 for pregnant one. As for prolificcacy a note of zero was given for no birth, 1 for single birht and 2 for twin birht. During the studies the birth weight of lambs and their survival rate were also recorded until they were 2 months of age.

3.2.8 Methods of statistical analysis

The collected data of all measured growth parameters were subjected to 3 way ANOVA analysis where age, weight, and breeding system were considered as independent variables; the dependant variables included body weight, tail length, tail volume and tail circumference. The interraction between the parameters were also reported. This variance analysis was done using SAS (for Windows, version 9.1.3, 2002). In the same way, the effect of parameters on the reproductive performances were determined: Fertility rate was considered as binomial variable (0=open, 1= pregnant), while prolificacy was considered as trinomial variable (0= no birth, 1=single birth, 2=twin birth)

The graphs were drawn using Excel (2003) and slidewrite (for windows, version 6, 2002).

4 RESULTS OF THE EXPERIMENT AND DISCUSSION

4.1 First experiment

4.1.1 The qualitative and quantitative nutritional value of the pasture

The average daily feed intake at pasture for each experimental group of ewes was registered. The proportions of plants grazed by the sheep flock were recorded and abundance estimated.

According to table 9, the average feed intake decreases from the month of July till the month of November. The decrease in feed intake could be associated with forage depletion as result of overgrazing, a decrease in vegetation variability as well as an increase in undesired tough vegetation types. Higher temperatures during the month of August could contribute to the observed decrease in feed intake.

During these months, observations showed that the majority of available plants consisted of herbaceous plants, grasses, cereals and vegetables as shown in figure 4 and figure 5. Thorny plants were also abundant especially after September. Trees and shrubs were rare specifically made of *Quercus calliprinos*. Among identified cereals, oat (*Avena sativa)* was the most dominant species whereas among vegetables, clover (*Trifolium patense*) and *Medicago radiata* were the most widespread species.

Based on the change in composition of pasture vegetation, it seems that the herbaceous plants were selected by the animals predominatly during the early months of the study, coinciding with thr first two reproductive phases (P1 and P2). During these two phases the grasses and the vegetables did dominate the pastures. They were the main source of feed which nourished the various groups of the females, thus occupying a proportion of 95 % of the grazed material.

During the later months, or the last two reproductive phases (P3 and P4), the ground did dried up and did no longer offer a great diversity; the majority of the species consumed during these two phases are primarily made up of thorny plants and dry leaves of trees and shrubs (70%).

Table 9: Average daily pasture feed intake of Awassi ewes and pasture composition

Source of variation		**LS means(±Se) of average monthly feed intake (g)**				
		June	July	August	September	October
Overall	72					
Age group		Ns	ns	ns	**	**
Hogget	24	540±76	575±43	621±107	507±49	443±78
Primiparous	24	1090±123	1110±79	983±76	772±78	677±91
Multiparous	24	1220±156	1260±157	1000±196	967±101	857±104
Weight group		Ns	ns	ns	**	**
Small weight	36	897±91	957±98	866±123	769±176	685±237
Large weight	36	990±105	1010±101	917±196	811±125	759±217
Management		Ns	ns	ns	**	**
Traditionnal	36	997±103	937±121	916±133	827±174	785±135
Improved	36	940±75	980±101	877±157	779±99	759±176
Vegetation type		**Vegetation names and % of prevailance.**				
Herbaceous plants		Avena sativa			Avena sativa	
		Trifolium sp			Trifolium sp	
		Medicago radiata			Achillea odorata	
		Salvia acetabolus			Onobrychis cornuta	
		Berberis libanotica				
		Cressa cretica				
% grazed		95			30	
Trees and Shrubs		Prunus ursina			Quercus calliprinos	
		Rosa glutinosa			Pyrus syriaca	
		Amygdalus orientalis			Rosa glutinosa	
% presence		5			70	

ns = non significant, ** = $p<0.05$

The nutrtionnal value of the pasture was evaluated monthly, protein content, ash and DM content were listed in table 10.

Table 10: Total nutritive values (DM basis) of pasture during the different months of the experiment.

Month	DM	EE	CP	ash	Ca	P	CF	ADF	NDF
June	56.80	3.65	12.5	5.66	2.15	0.33	32	41	57
July	57.32	3.92	11.7	6.55	2.18	0.27	29	40	52
August	60.80	3.70	10.9	6.57	2.14	0.29	40	45	58
September	61.82	3.75	9.5	9.47	1.26	0.23	40	39	55
October	65.7	3.20	8.7	9.77	1.29	0.16	50	37	56

As shown in table 10, the dry matter DM content of pasture vegetation was higher during October and September than in June and July months. Grazed spontaneous vegetation of June and July months were still greens probably due to the snow melt during spring months which stimulated the emergence of annual herbaceous vegetation. During the months of September and October the grazed vegetations were mainly stems of shrubs and trees with lower water content. The crude protein average content of pasture vegetation during the different months ranged between 8.7% and 12%, higher than reported averages by Smith (1984), Smith(1984) estimated the annual mature pasture crude protein content ranges from 5 to 10%. In this experiment greater availability of legumes could account for the higher pasture protein content (Mcvickar and Mckvikar,1963). Same scenario applies to the higher calcium and phosphorous (Mcvickar and Mckvikar,1963) due to higher legumes which explain the availability of those minerals in the pasture mixture. Crude protein content were lower in September and October months. This could be due to the scarcity of legumes and annual herbaceous plants during these months and the abondance of tree leaves and stems which are less rich in protein (Smith, 1984).

Thus, the spontaneous available vegetation seems to satisfy the nutritional needs for the females in spring and beginning of summer. High temperatures recorded during August as well as subsequent overgrazing reduce the feed value of the pasture sites, not satisfying the increased energy needs for the pregnant females. ACSAD (1986) reported that spontaneous vegetation in Lebanese pastures included shrubs, hardy perennials and grasses, the majority of which grow during the season of winter and spring. These results are also similar to those obtained by Abi Saab *et al.* (1998) who mentioned that in the Bekaa area the majority of vegetation on range land from

March till August is especially made up of leguminous plants of graminaeceous plants which are rich in protein, calcium and phosphorus. All together, the protein and mineral needs of Awassi are satisfied in this grazing season (June to August), and before the vegetation becomes poorer as of September. Hamadeh *et al.* (1996) showed that supplements are essential during autumn and winter (October-November) which corresponds to the period of the end of pregnancy and beginning of lactation.

The annual variation in vegetation is accounted for by the cycle of snow melt, at the end of winter. This cycle boosts the development of the annual plants before they disappear progressively with the dry period. In the dry season, sheep mobilize fat reserves and feed on and browse trees and shrubs in order to compensate the loss of growing material.

Figure 4. Typical rangeland in Bekaa valley in August.

Figure 5. Typical range land in Bekaa Valley in August.

4.1.2 Body growth measurements

The parameters of body growth are represented by body weight, body chest girth and body length.

The averages values of body growth measurements for the various groups of females during all the phases of the reproductive period are represented in tables 11,12,13 and 14.

Table 11: Body growth measurements of Awassi sheep during P1 of the reproduction period.

Source of variation		**P1**		
Age	**Group**	**Body weight (kg) ± SE**	**Body chest girth (cm) ± SE**	**Body length (cm) ± SE**
Hoggets	Hsw	20.67 ± 1.53^a	66.89 ± 7.50^a	54.89 ± 9.41^a
(n=6)	Hsw^+	20.58 ± 1.17^a	68.11 ± 6.61^a	58.39 ± 6.50^b
	Hlw	23.78 ± 0.73^b	72.50 ± 4^b	59.33 ± 3.40^b
	Hlw^+	24.97 ± 1.49^b	74.11 ± 3.95^b	60.44 ± 7.05^b
Total (n=24)		$\mathbf{22.60\pm2.31^a}$	$\mathbf{70.55\pm6.29^a}$	$\mathbf{58.35\pm6.97^a}$
Primiparous	Psw	34.81 ± 1.82^a	80.29 ± 4.50^a	67.05 ± 5.13^a
(n=6)	Psw^+	34.08 ± 1.82^a	80.94 ± 3.10^a	67.67 ± 3.76^a
	Plw	41.56 ± 2.74^b	85 ± 4.23^b	70.44 ± 4.90^a
	Plw^+	40.65 ± 2.02^b	83.63 ± 2.14^b	69.17 ± 3.48^a
Total (n=24)		$\mathbf{38.22\pm3.96^a}$	$\mathbf{82.51\pm3.98^a}$	$\mathbf{68.59\pm4.46^a}$
Multiparous	Msw	42.03 ± 1.22^a	80.17 ± 7.79^a	64.19 ± 6.67^a
(n=6)	Msw^+	42.23 ± 1.57^a	82.50 ± 7.09^a	65.02 ± 4.98^a
	Mlw	46.31 ± 0.99^b	86.71 ± 8.99^b	66.98 ± 5.63^a
	Mlw^+	47.31 ± 1.14^b	86.71 ± 5.08^b	68.88 ± 7.55^a
Total(n=24)		$\mathbf{44.67\pm2.63^a}$	$\mathbf{83.50\pm7.53^a}$	$\mathbf{66.19\pm6.33^a}$
Management				
N=36	traditional	34.86 ± 1.50^a	78.59 ± 6.16^a	63.81 ± 5.85^a
N=36	improved	34.97 ± 1.62^a	79.33 ± 4.67^a	64.92 ± 5.55^b

a, b, c: In column, for each group of the animals and each phase, on line, for the total enters
period, the figures with different exhibitors represent a significant difference with $p<0.05$.
P1 = first phase of the reproductive period or hot phase; P2 = second phase of the reproductive phase or mating phase; P3 = Third phase of the reproductive phase or dry phase; P4 = fourth phase of the reproductive period or rainfall phase.; H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight; + = supplementation.

Table 12: Body growth measurements of Awassi sheep during P2 of the reproduction period

Source of variation		P2		
Age	**Group**	**Body weight (kg) ± SE**	**Body chest girth (cm)± SE**	**Body length (cm) ± SE**
Hoggets	Hsw	22.69±2[a]	72.17±6.77[a]	58.88±9.21[a]
(n=6)	Hsw+	23.17±0.87[a]	75±6.48[b]	62.04±4.24 [b]
	Hlw	25.17±1.48[b]	75.92±3.44[bc]	64.42±5.49[bc]
	Hlw+	25.56±1.75[b]	77.17±4.98[c]	66.79±6.56[c]
Total (n=24)		**24.20±1.99 [b]**	**75.16±5.69 [b]**	**63.18±7.07 [b]**
Primiparous	Psw	35.98±1.55[a]	86.82±1.46[a]	72.29±3.38[a]
(n=6)	Psw+	36.23±1.75[a]	85.42±1.65 [a]	73±2.32 [a]
	Plw	43.28±2.98[b]	91.04±2.81[b]	75.36±5[a]
	Plw+	43.41±2.28[b]	91.34±2.17[b]	74.97±2.73[a]
Total (n=24)		**40.21±4.23 [b]**	**88.88±5.40 [b]**	**73.98±3.78 [b]**
Multiparous	Msw	43.77±1.24[a]	84.92±1.16 [a]	70.83±6.51 [a]
(n=6)	Msw+	44.98±1.17[a]	88.66±0.99[ab]	71.83±5.25[a]
	Mlw	47.13±1.06[b]	91.89±1.13[b]	72.46±4.20 [a]
	Mlw+	49.02±1.63[c]	91.89±1.52[b]	74.71±5.33 [a]
Total(n=24)		**46.37±2.37 [b]**	**88.63±5.86 [b]**	**72.55±5.44 [b]**
Management				
N=36	traditional	36.33±1.71 [a]	83.79± 2.79 [a]	68.14 ± 5.15 [a]
N=36	Improved	37.06 ±1.57 [a]	84.91± 2.96 [a]	71.45± 4.88 [b]

a, b, c: In column, for each group of the animals and each phase, on line, for the total enters

period, the figures with different exhibitors represent a significant difference with $p<0.05$.

P1 = first phase of the reproductive period or hot phase; P2 = second phase of the reproductive phase or mating phase; P3 = Third phase of the reproductive phase or dry phase; P4 = fourth phase of the reproductive period or rainfall phase. H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight; + = supplementation

Table 13: Body growth measurements of Awassi sheep during P3 of the reproduction period

Source of variation		P3		
Age	**Group**	**Body weight (kg) ± SE**	**Body chest girth (cm) ± SE**	**Body length (cm)± SE**
Hoggets	Hsw	23.78±2.39 [a]	76.11±4.16[a]	66.56±6.22[a]
(n=6)	Hsw+	25.33±1.41[ab]	78.39±7.69[b]	69.22±4.66[b]
	Hlw	26.19±2.04[ab]	79.06±2.34[b]	69.67±5.66[b]
	Hlw+	27.33±2.20[b]	79.89±7.11[b]	70.72±5.19[b]
Total (n=24)		**25.73±2.37 [bc]**	**78.42±5.70 [bc]**	**69.11±5.47 [c]**
Primiparous	Psw	38.07±1.96[a]	90±1.83 [a]	76.52±5.30 [a]
(n=6)	Psw+	38.61±1.06[a]	89.94±1 [a]	77.06±3.57[a]
	Plw	45.19±3[b]	94.56±2.83[b]	78.25±3.94 [a]
	Plw+	46.63±2.29[b]	96±2.18[b]	78.71±3.51[a]
Total (n=24)		**42.64±4.42 [c]**	**92.89±5.33 [c]**	**77.71±4.17 [c]**
Multiparous	Msw	45.28±2.50[a]	91.94±2.32 [a]	77.89±8.09[a]
(n=6)	Msw+	47.92±1.55[ab]	95.95±1.48[b]	78±6.08[a]
	Mlw	48.40±1.22 [b]	95.10±1.16[b]	78.14±3.62 [a]
	Mlw+	50.56±2.12[c]	95.95±1.96[b]	79.24±3.55 [a]
Total(n=24)		**48.15±2.61 [c]**	**94.21±4.07 [c]**	**78.38±5.44 [c]**
Management				
N=36	Traditional	37.81±2.18 [a]	87.79±2.44[a]	74.50 ± 5.47 [a]
N=36	Improved	39.39 ±1.77 [b]	89.35± 3.57 [b]	75.49± 4.42 [b]

a, b, c: In column, for each group of the animals and each phase, on line, for the total enters

period, the figures with different exhibitors represent a significant difference with $p<0.05$.

P1 = first phase of the reproductive period or hot phase; P2 = second phase of the reproductive phase or mating phase; P3 = Third phase of the reproductive phase or dry phase; P4 = fourth phase of the reproductive period or rainfall phase. H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight; + = supplementation

Table 14: Body growth measurements of Awassi sheep during P4 of the reproduction period

Source of variation		P4		
Age	**Group**	**Body weight (kg) ± SE**	**Body chest girth (cm)± SE**	**Body length (cm)± SE**
Hoggets	Hsw	23.83±2.89^{a}	76.83±3.93^{a}	69.33±2.88^{a}
(n=6)	Hsw^{+}	26.83±1.94^{b}	79.67±6.86^{b}	72±3.90^{b}
	Hlw	27±2.35^{b}	80.83±2.64^{b}	72.33±2.88^{b}
	Hlw^{+}	28.58±2.29^{b}	82.17±7.76^{b}	72.33±2.61^{b}
Total (n=24)		**26.15±3.50^{c}**	**79.88±5.61^{c}**	**71.50±4.77^{c}**
Primiparous	Psw	39.50±2.16^{a}	92.43±6.59^{a}	79.14±5.26^{a}
(n=6)	Psw^{+}	40±1.38^{a}	92.67±4.52^{a}	80±3.08^{a}
	Plw	46±4.02^{b}	96±3.51^{b}	79.57±7.16^{a}
	Plw^{+}	48.25±3.02^{b}	97.38±4.50^{b}	81±4.37^{a}
Total (n=24)		**43.81±4.73^{c}**	**94.79±5.39^{c}**	**79.96±4.69^{c}**
Multiparous	Msw	46.25±1.51^{a}	94.67±8.68^{a}	80.83±1.63^{a}
(n=6)	Msw^{+}	50.08±3.14^{b}	95.33±6.51^{a}	80±5.50^{a}
	Mlw	50.21±2.80^{b}	97.86±3.08^{ab}	80.14±5.70^{a}
	Mlw^{+}	52.33±2.23^{b}	98.25±3.34^{b}	82.86±3.37^{a}
Total(n=24)		**49.74±3.21^{c}**	**96.70±4.40^{c}**	**81±5.46^{c}**
Management				
N=36	Traditional	38.79±2.62^{a}	89.77± 4.73^{a}	76.89 ± 4.25^{a}
N=36	Improved	41.01 ±2.33^{b}	90.91± 5.58^{b}	78.03± 3.80^{b}

a, b, c: In column, for each group of the animals and each phase, on line, for the total enters

period, the figures with different exhibitors represent a significant difference with $p<0.05$.

P1 = first phase of the reproductive period or hot phase; P2 = second phase of the reproductive phase or mating phase; P3 = Third phase of the reproductive phase or dry phase; P4 = fourth phase of the reproductive period or rainfall phase. H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight; + = supplementation

There was a significant ($p<0.01$) age by weight interaction. The effect of the contribution of supplements on body weight was highly significant ($p<0.01$) during the two last phases (P3 and P4) of the reproduction period. This is due to the poor pasture during these phases. Supplements become essential to satisfy the energy and protein needs of females and consequently, maintain a good body growth.

According to tables 11, 12, 13 and 14, the average values of body weights were significantly ($p<0.05$) higher in hoggets of the lw group compared to those of the sw group during the first two phases of the reproduction period P1 (23.78±0.73 and 24.97±1.49 kg vs 20.67±1.53 and 20.58±1.17) and P2 (25.17±1.48 and 25.56±1.75 vs 22.69±2 and 23.17±0.87 kg), for the four groups Hlw, Hlw+, Hsw and Hsw+ respectively. During the P3 and P4 phases, the low weight of hoggets of the improved system (Hsw+) showed body weights significantly higher ($p<0.05$) than those of the low weight hoggets (sw) of the traditional system (Hsw) (P3: 25.33±1.41 vs 23.78±2.39 and P4: 26.83±1.94 vs 23.83±2.89) respectively.

The large weight primiparous ewes (Plw) of the improved and traditional systems showed body weight significantly higher ($p<0.05$) than in low weight group of the two systems during the four phases (P1: 41.56±2.74 and 40.65±2.02 vs 34.81±1.82 and 34.08±1.82; P4: 46±4.02 and 48.25±3.02 vs 39.50±2.16 and 40±1.38 for the four groups Plw, Plw+, Psw and Psw+ respectively).

During the first phase P1, the high weight multiparous (Mlw) group of the two systems also showed body weights that are more significantly higher ($p<0.05$) than those of the low weight multiparous (Msw) groups of the two systems (46.31±0.99 and 47.31±1.14 vs 42.03±1.22 and 42.23±1.57 respectively). During P2 and P3, low weight and high weight multiparous (Msw and Mlw) groups of the improved system were significantly heavier ($p<0.05$) than those of the traditional system (44.98±1.17 and 49.02±1.63 during the phase P2 and 47.92±1.55 and 50.56±2.12 during P3) and (43.77±1.24 and 47.13±1.06 during P2 and 45.28±2.50 and 48.40±1.22 kg during P3 phase). During the last phase, P4, the low weight multiparous (Msw) animals of the traditional system maintained a lower body weight ($p<0.05$) than those of the other three groups.

Body weight evolution of the four groups of hoggets was almost similar during phases P1 and P2 as shown in fig. 6. This evolution then is more marked during P3 and P4 in hoggets of the improved system than those of traditional one.

Figure 9 showed that hoggets of the improved system showed a better daily weight gain throughout the 4 different phase of the experiment ($p<0.05$). During the third period of the study, all groups of hoggets excempt large weight hoggets of the improved system showed a decrease in daily weight gain with respect to the two previous period. During the fourth period, all groups of hoggets showed a decrease of this parameter. It could be concluded that even so the addition of supplements in the diets of hoggets could alleviate the problems of scarcity of pasture during these periods but it could not resolve it. The amount and the quality of supplements to be adopted is in need for further investigation.

Figure 6. Evolution of body weights of hoggets during the reproductive period.

lw = high weight; sw = low weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

In addition, according to figure 6, the four groups of primiparous showed a similar evolution of body weight as shown in figure 7. This evolution was more marked for multiparous of the improved system than for those of traditional system (fig.8).

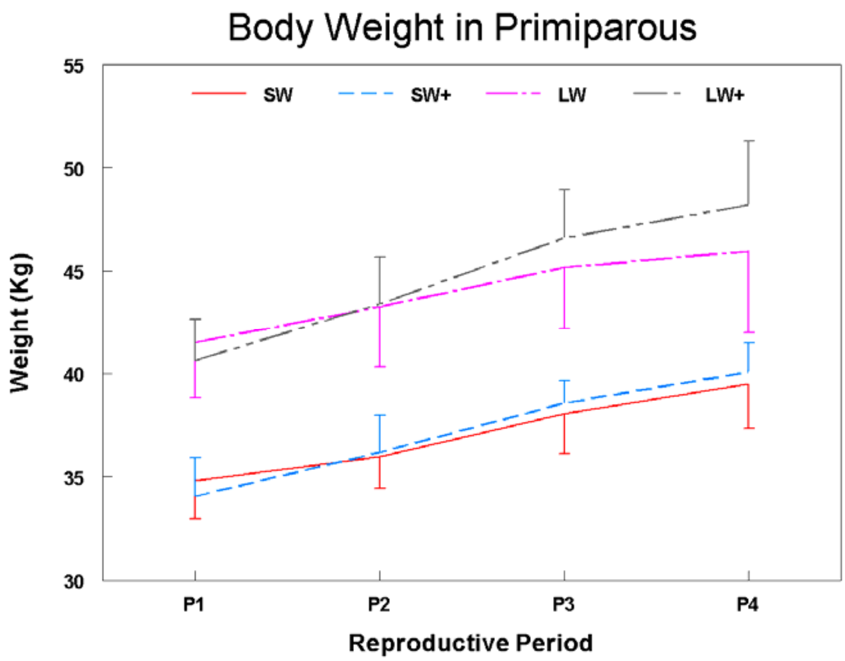

Figure 7. Evolution of body weight for primiparous ewes during the reproductive period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

Figure 8. Evolution of body weight for multiparous ewes during the reproducitve period

lw = large weight;sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

As shown in figures 10 and 11, the average daily weight gain of primiparous and multiparous showed the same trends of hoggets with a marked decrease at the fourth period for all the groups of females.

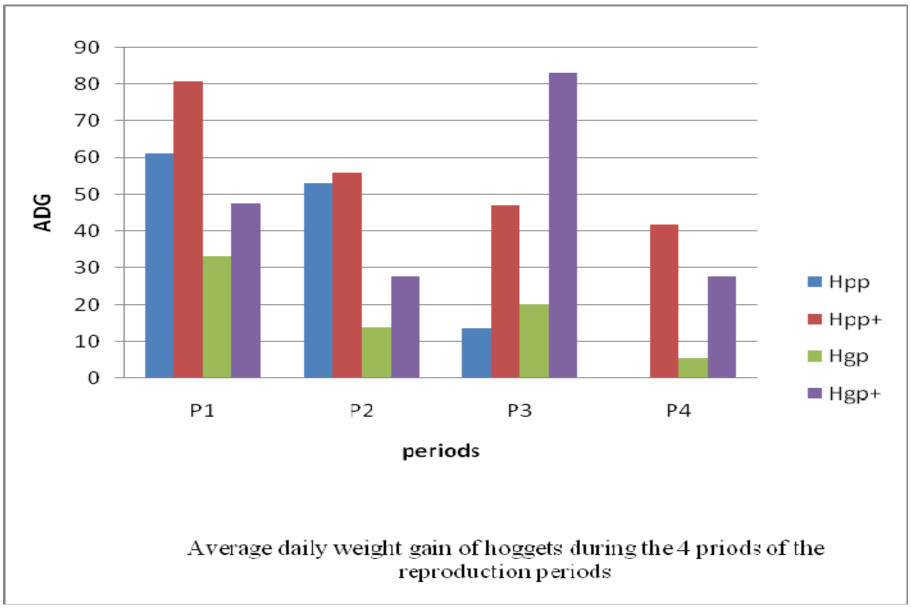

Figure 9. Average daily weight gain of hoggets during the 4 phases of the reproductive period.

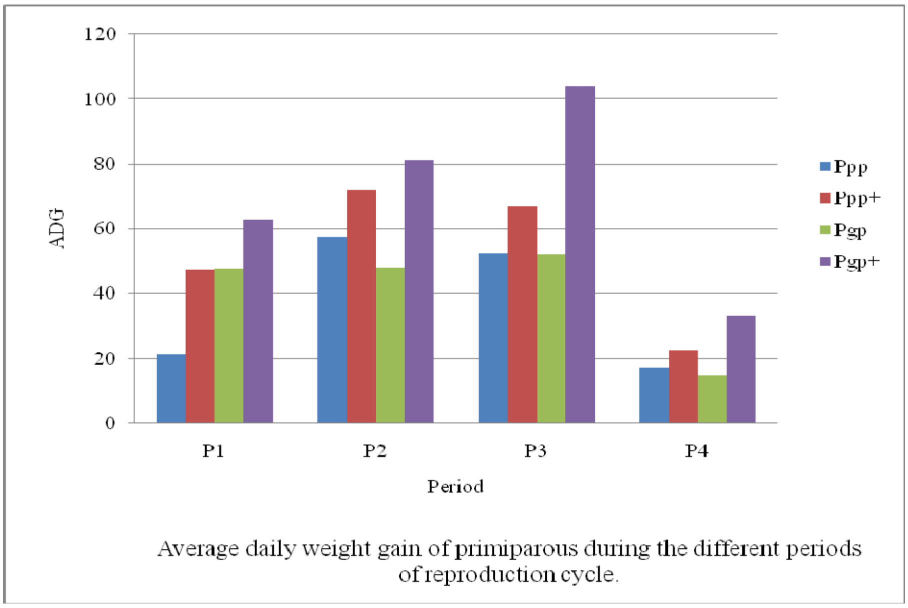

Figure 10. Average daily weight gain of primiparous during the 4 phases of the reproductive period.

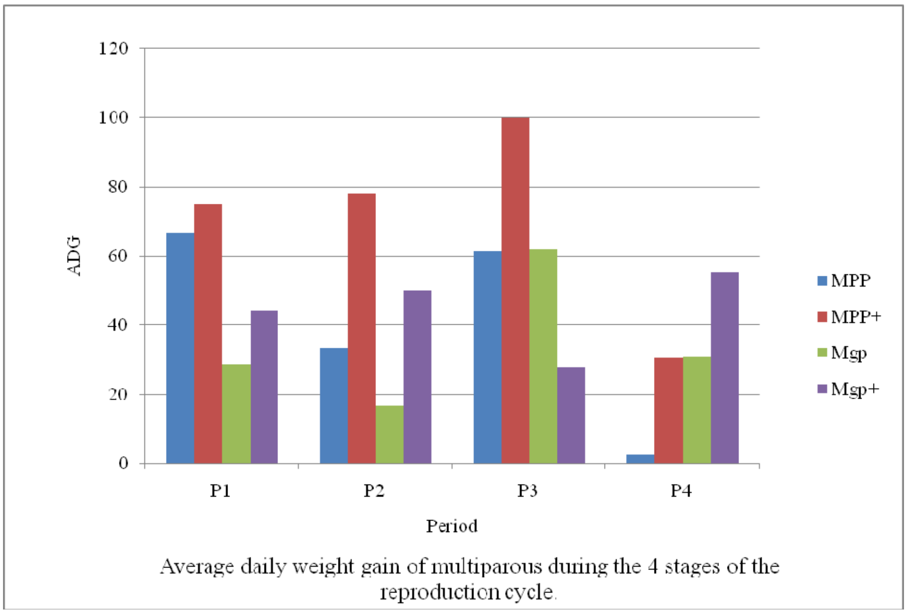

Figure 11. Average daily gain for multiparous during the 4 phases of the reproductive period.

The results of ANOVA indicates that age, weight and breeding system (Appendix 8.2 and 8.3) had a significant effect on body chest girth in the various groups of females during four phases of the reproduction period.

The interaction between the three factors age, weight and system of breeding is non-significant.

According to tables 11, 12, 13 and 14:

The body chest girth of high weight hoggets (Hlw) of the both systems (Hlw and Hlw+) was significantly larger ($p<0.05$) than those of the sw group during two phases P1 (72.50±4 and 74.11±3.95 vs 66.89±7.50 and 68.11±6.61) and P2 (75.92±3.44 and 77.17±4.98 vs 72.17±6.77 and 75±6.48 cm) for the four groups Hlw, Hlw+, Hsw and Hsw+ respectively. During the last two phases P3 and P4, body chest girth of low weight hoggets (Hsw) of the improved system was significantly larger ($p<0.05$) than those of the traditional system (78.38±7.69 vs 76.11±4.16 cm during the P3 phase and 79.67±6.86 vs 76.83±3.93 cm during P4 phase) for the two groups Hsw $^{+}$ and Hsw respectively.

The large weight primiparous (Plw) group of the improved and traditional system, showed average values of their body chest girth which were significantly larger ($p<0.05$) compared to those low weight (sw) groups during the various phases of the reproduction period (P1: 85±4.23 and 83.63±2.14 vs 80.29±4.50 and

80.94±3.10; P4: 96±3.51 and 97.38±4.50 vs 92.43±6.59 and 92.67±4.52) and this at the four groups Plw, Plw+, Psw and Psw+ respectively.

No significant difference did exist between primiparous ewes of the improved system (Psw+ and Plw+) and those of traditional system (Psw and Plw) during the four phases of the reproduction period.

Parallel to the primiparous animals, the large weight multiparous (lw) groups of the improved and traditional system maintained a body chest girth ($p<0.05$) higher than those of low weight (sw) of the two systems (P1: 86.71±8.99 and 86.71±5.08 vs 80.17±7.79 and 82.50±7.09; P4: 97.86±3.08 and 98.25±3.34 vs 94.67±8.68 and 95.33±6.51) and this at the four groups Mlw, Mlw+, Msw and Msw+ respectively).

Concerning body length , the results of ANOVA analysis (Appendix 8.3) indicate that age, body weight and management have a significant effect on body length for the various groups of females during the different phases of the reproduction period.

The interaction between the three factors was negligible.

According to tables 11, 12, 13 and 14, body length of low weight hoggets (Hsw) of the improved system were significantly ($p<0.05$) larger compared to those of traditional system.

In contrast between primiparous and multiparous ewes, no significant differences were noted for body lengths between groups.

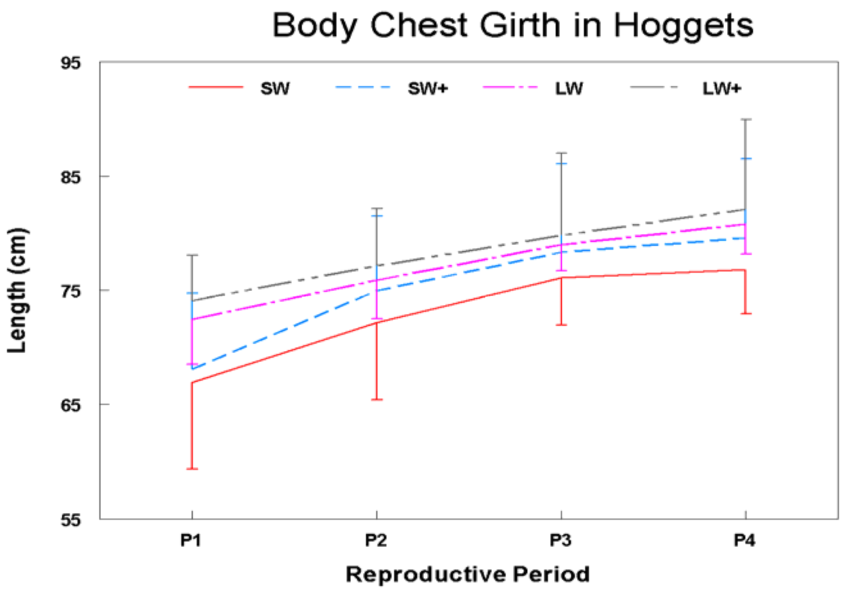

Figure 12. Evolution of body chest girth for hoggets during the reproductive period.

lw = large weight;sw = small weight; += supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

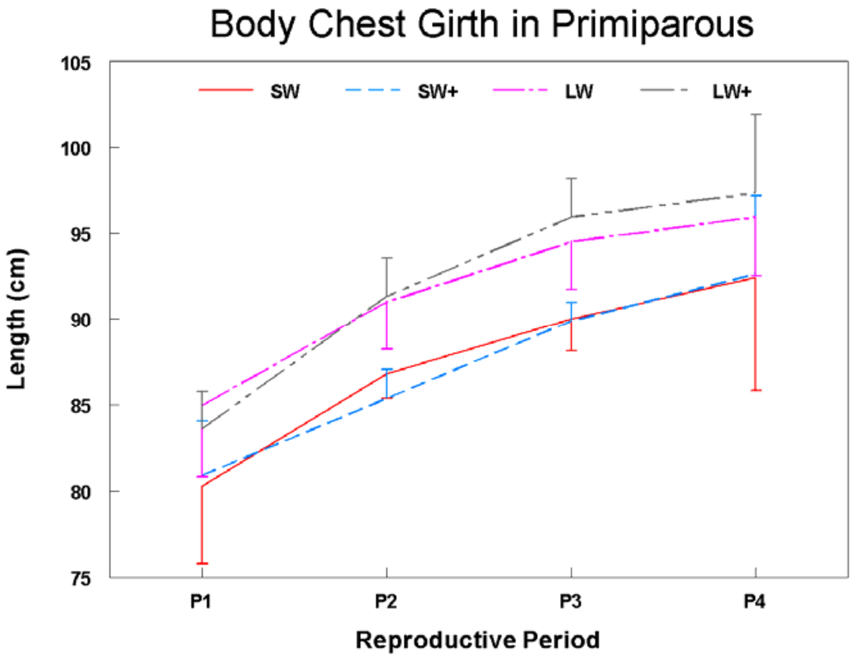

Figure 13. Evolution of body chest girth for primiparous ewes during the reproductive period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

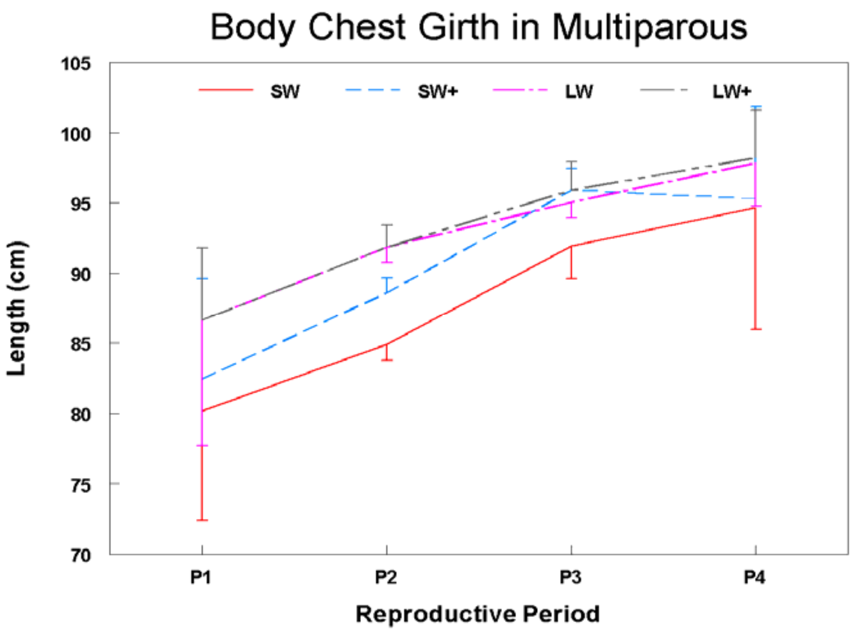

Figure 14. Evolution of body chest girth for multiparous ewes during the reproductive period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

4.1.3 Tail measurements

The average values of the tail measurements represented by length, circumference and tail volume are presented in tables 15, 16, 17 and 18.

Table 15: Tail measurements of experimented females Awassi during P1of the reproduction period

Source of variation		**P1**		
Age group	**Weight group**	**tail length± SE**	**Tail circumference± SE**	**Tail volume± SE**
Hoggets	Hsw	21.89±3.31 ^{a}	24.50±4.57^{a}	0.45±0.24 ^{a}
(n=6)	Hsw^{+}	24.17±4.08^{b}	26.11±4.48^{b}	0.65±0.33^{b}
	Hlw	25.28±2.70^{bc}	28.81±2.37^{c}	0.75±0.38^{b}
	Hlw^{+}	26.56±3.05^{c}	28.94±3.84^{c}	0.75±0.29^{b}
Total (n=24)		**24.28±3.51** ^{a}	**27.14±4.19** ^{a}	**0.66±0.33** ^{a}
Primiparous	Psw	24.43±1.66 ^{a}	32±2.07 ^{a}	1.23±0.22^{a}
(n=6)	Psw^{+}	23.39±2.55 ^{a}	31.50±2.64 ^{a}	1.18±0.18^{a}
	Plw	27.19±1.82^{b}	35.78±1.25^{b}	1.48±0.36^{b}
	Plw^{+}	27.52±3.61^{b}	36.94±3.08^{b}	1.53±0.41^{b}
Total (n=24)		**25.83±3.02** ^{a}	**34.12±3.26** ^{a}	1.38±0.34 ^{a}
Multiparous	Msw	29.06±2.86^{a}	30.22±4.35^{a}	1.27±0.19 ^{a}
(n=6)	Msw^{+}	31.44±3.13^{b}	33.72±3.46^{b}	1.51±0.38^{b}
	Mlw	32.05±2.96^{bc}	35.81±3.03^{bc}	1.56±0.23^{b}
	Mlw^{+}	33.72±4.88^{c}	38.83±3.84^{c}	1.77±0.47^{c}
Total (n = 24)		**31.67±3.83** ^{a}	**35.14±4.81** ^{a}	1.54±0.37 ^{a}
Management		*	*	**
N=36	Traditional	26.65±2.55 ^{a}	31.18± 2.94 ^{a}	1.12 ± 0.27 ^{a}
N=36	Improved	27.8 ±3.55 ^{b}	32.66± 3.55 ^{b}	1.23± 0.34 ^{b}

a, b, c: In column, for each group of the animals and each phase, on line, for the total enters
period, the figures with different exhibitors represent a significant difference with $p<0.05$.
P1 = first phase of the reproductive period or hot phase; P2 = second phase of the reproductive phase or mating phase; P3 = Third phase of the reproductive phase or dry phase; P4 = fourth phase of the reproductive period or rainfall phase. H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight; + = supplementation

Table 16: Tail measurements of experimented females Awassi during P2 of the reproduction period

Source of variation		**P2**		
Age group	**Weight group**	**tail length± SE**	**Tail circumference± SE**	**Tail volume± SE**
Hoggets	Hsw	25.29±3.56 ^{a}	25.75±4.84 ^{a}	0.65±0.27 ^{a}
(n=6)	Hsw $^{+}$	26.38±3.674 ^{b}	28.25±4.31 ^{b}	0.91±0.26 ^{b}
	Hlw	26.92±2.65 ^{b}	30.21±1.59 ^{c}	0.98±0.23 ^{b}
	Hlw $^{+}$	26.71±2.84 ^{b}	30.21±3.72 ^{c}	0.96±0.26 ^{b}
Total (n=24)		**26.34±3.16 ^{b}**	**28.67±4.11 ^{a}**	**0.88±0.27 ^{b}**
Primiparous	Psw	26.75±1.84 ^{a}	33.32±1.74 ^{a}	1.37±0.33 ^{a}
(n=6)	Psw $^{+}$	29±3.44 ^{b}	34.04±2.71 $_{a}$	1.35±0.33 ^{a}
	Plw	29.80±1.82 ^{bc}	37.60±2.63 ^{b}	1.58±0.40 ^{ab}
	Plw $^{+}$	31.39±3.90 ^{c}	39.04±2.39 ^{b}	1.67±0.16 ^{b}
Total (n=24)		**29.34±3.28 ^{b}**	**36.07±3.36 ^{ab}**	1.51±0.36 ^{b}
Multiparous	Msw	29.67±2.96 ^{a}	31±3.92 ^{a}	1.31±0.16 ^{a}
(n=6)	Msw $^{+}$	33.17±4.26 ^{bc}	36.71±3.83 ^{b}	1.60±0.32 ^{b}
	Mlw	32.61±3.18 ^{b}	36.89±3.03 ^{b}	1.60±0.24 ^{b}
	Mlw $^{+}$	35.56±4.71 ^{c}	40±4.06 ^{c}	1.88±0.52 ^{b}
Total (n = 24)		**32.85±4.29 ^{a}**	**36.59±4.90 ^{ab}**	1.61±0.38 ^{a}
Management				
N=36	traditional	28.50± 2.66 ^{a}	32.46± 2.95 ^{a}	1.24 ± 0.27 ^{a}
N=36	improved	30.03± 3.80 ^{b}	34.70± 3.50 ^{b}	1.39± 0.30 ^{b}

a, b, c: In column, for each group of the animals and each phase, on line, for the total enters
period, the figures with different exhibitors represent a significant difference with $p<0.05$.
P1 = first phase of the reproductive period or hot phase; P2 = second phase of the reproductive phase or mating phase; P3 = Third phase of the reproductive phase or dry phase; P4 = fourth phase of the reproductive period or rainfall phase. H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight; + = supplementation

Table 17: Tail measurements of experimented females Awassi during P3 of the reproduction period

Source of variation		**P3**		
Age group	**Weight group**	**tail length± SE**	**Tail circumference± SE**	**Tail volume± SE**
Hoggets	Hsw	25.5±3.52 [a]	27.72±3.52 [a]	0.89±0.27 [a]
(n=6)	Hsw^+	27.94±3.67 [bc]	31.33±3.67 [b]	1.15±0.18 [b]
	Hlw	27±3.09 [ab]	33±3.09 [b]	1.13±0.22 [b]
	Hlw^+	29.67±3.38 [c]	33.39±3.38 [b]	1.29±0.31 [b]
Total (n=24)		**27.61±3.65 [bc]**	**31.44±4.42 [b]**	**1.12±0.28 [c]**
Primiparous	Psw	28±2.30 [a]	34.67±1.78 [a]	1.43±0.25 [a]
(n=6)	Psw^+	32.11±5.28 [b]	37.28±2.07 [b]	1.54±0.46 [b]
	Plw	32.13±2.49 [bc]	39±1.97 [bc]	1.63±0.24 [b]
	Plw^+	34.19±4.35 [c]	42.03±3.85 [c]	1.83±0.56 [c]
Total (n=24)		**31.70±4.29 [bc]**	**38.39±3.88 [b]**	1.62±0.43 [b]
Multiparous	Msw	30.11±2.95 [a]	32.06±3.83 [a]	1.33±0.21 [a]
(n=6)	Msw^+	33.86±3.93 [b]	38.72±4.40 [b]	1.73±0.36 [b]
	Mlw	32.52±3.03 [b]	38.07±3.78 [b]	1.67±0.35 [b]
	Mlw^+	36.69±4.68 [c]	43.17±4.09 [c]	1.96±0.72 [c]
Total (n = 24)		**33.40±4.31 [a]**	**38.56±5.62 [b]**	1.68±0.49 [a]
Management				
N=36	Traditional	28.50± 2.66 [a]	34.08± 2.99 [a]	1.24 ± 0.27 [a]
N=36	Improved	32.41± 4.215 [b]	37.65± 3.57 [b]	1.39± 0.30 [b]

a, b, c: In column, for each group of the animals and each phase, on line, for the total enters
period, the figures with different exhibitors represent a significant difference with $p<0.05$.
P1 = first phase of the reproductive period or hot phase; P2 = second phase of the reproductive phase or mating phase; P3 = Third phase of the reproductive phase or dry phase; P4 = fourth phase of the reproductive period or rainfall phase.H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight; + = supplementation

Table 18: Tail measurements of experimented females Awassi during P4 of the Reproduction period

Source of variation		P4		
Age group	**Weight group**	**tail length± SE**	**Tail circumference± SE**	**Tail volume± SE**
Hoggets	Hsw	25.67±2.88[a]	32.88±4.13[a]	0.91±0.24[a]
(n=6)	Hsw+	30±3.90[b]	34.92±3.72[b]	1.18±0.15[b]
	Hlw	27.67±2.88[b]	34.17±4.07[b]	1.01±0.25[ab]
	Hlw+	33±2.61[c]	35.27±4.18[b]	1.46±0.26[c]
Total (n=24)		**29.08±4.02[c]**	**34.31±3.87[c]**	**1.14±0.30[c]**
Primiparous	Psw	28.79±2.91[a]	36.43±1.99[a]	1.50±0.57[a]
(n=6)	Psw+	32.67±4.18[b]	38±3.22[a b]	1.67±0.41[ab]
	Plw	33±2.27[b]	39.57±2.30[b]	1.75±0.35[b]
	Plw+	35.14±5.21[c]	43.29±4.35[c]	1.87±0.51[b]
Total (n=24)		**32.41±4.24[c]**	**39.37±3.92[b]**	1.50±0.48[b]
Multiparous	Msw	30.83±2.40[a]	33.67±3.98[a]	1.37±0.16[a]
(n=6)	Msw+	34.17±4.55[b]	39.83±4.92[b]	1.84±0.44[b]
	Mlw	33.29±5.05[b]	39±4.32[b]	1.79±0.39[b]
	Mlw+	37.67±5.20[c]	44.31±4.77[c]	2.08±0.[61c]
Total (n = 24)		**33.96±4.85[a]**	**39.57±5.76[b]**	1.58±0.45[a]
Management				
Traditional	36	28.50± 2.66[a]	34.08± 2.99[a]	1.24 ± 0.27[a]
Improved	36	32.41± 4.215[b]	37.65± 3.57[b]	1.39± 0.30[b]

a, b, c: In column, for each group of the animals and each phase, on line, for the total enters
period, the figures with different exhibitors represent a significant difference with $p<0.05$.
P1 = first phase of the reproductive period or hot phase; P2 = second phase of the reproductive phase or mating phase; P3 = Third phase of the reproductive phase or dry phase; P4 = fourth phase of the reproductive period or rainfall phase. H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight; + = supplementation

The values of the tail lengths for the various groups of females during the reproduction period were subjected to a factorial ANOVA analysis (appendix 8.4). The results of the analysis indicate that age, body weight and breeding system had a significant effect on tail lenght for the various groups of females during the different phases of the reproduction period.

The interaction between the three factors was negligible.

According to tables 15, 16, 17 and 18; during the first phase P1, the tail lengths of high weight hoggets of the tradional and the improved system (Hlw and Hlw+) were significantly larger ($p<0.05$) than those of low weight (Hsw and Hsw+) animals of the two systems (25.28±2.70 and 26.56±3.05 vs 21.89±3.31 and 24.17±4.08 cm) for the four groups Hlw, Hlw $^{+}$, Hsw and Hsw $^{+}$ respectively).

During the second phase P2, the low weight hoggets (Hsw) of the traditional system had significantly smaller tails ($p<0.05$) than those of the other three groups (25.29±3.56 vs 26.38±3.67, 26.92±2.65 and 26.71±2.84) for the groups Hsw+, Hlw and Hlw+ respectively.

In contrast during two last phases P3 and P4, the average values of tail lenghts weresignificantly lower ($p<0.05$) for the two groups Hsw and Hlw of the traditional system than for those of the improved system (Hsw+ and Hlw+).

For the primiparous and multiparous animals of the high weight group, the average values of tail lengths were significantly higher ($p<0.05$) than those of primiparous group during the first phase of the reproduction period (Primiparous:27.19±1.82 and 27.52±3.61 vs 24.43±1.66 and 23.39±2.55; multiparous: 32.05±2.96 and 33.72±4.88 vs 29.06±2.86 and 31.44±3.13 for the four lw groups, lw+, sw and sw+ respectively), while during phases P2, P3 and P4, tail lengths measurements of primiparous and multiparous of the improved system were significantly higher ($p<0.05$) than those of the traditional system.

During the fourth phase, P4, as shown in fig. 15 a notable reduction of tail lengths in hoggets of the sw and lw of the traditional system, with rate of evolution of –10.7 and –2.46% for the two groups respectively occurred, whereas for the sw and le hoggets of the improved system (Hsw+ and Hlw+), tail growth did remain continuous and linear with rates of evolution of 6.18 and 21.5%. The same was noted for primiparous and multiparous animals (fig. 16 and fig. 17).

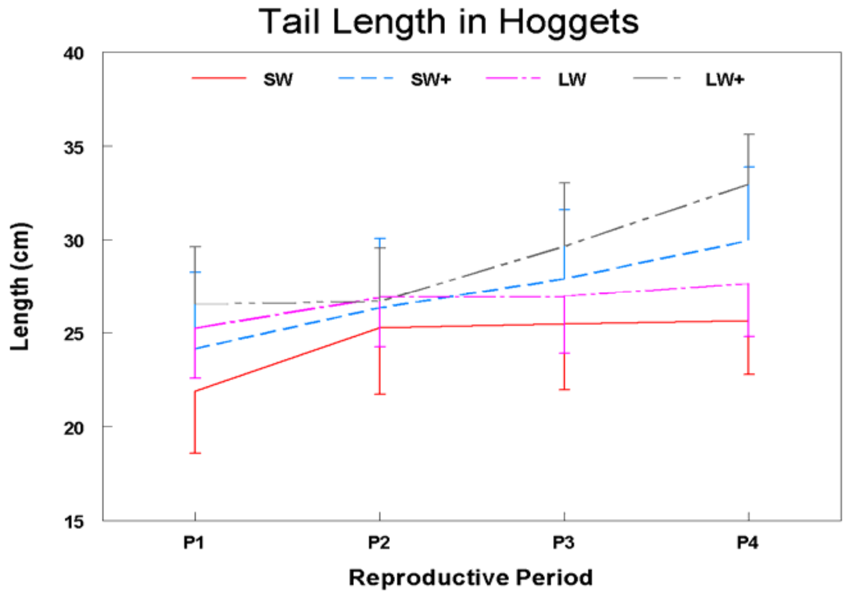

Figure 15. Evolution of tail length for hoggets during the reproductive period

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

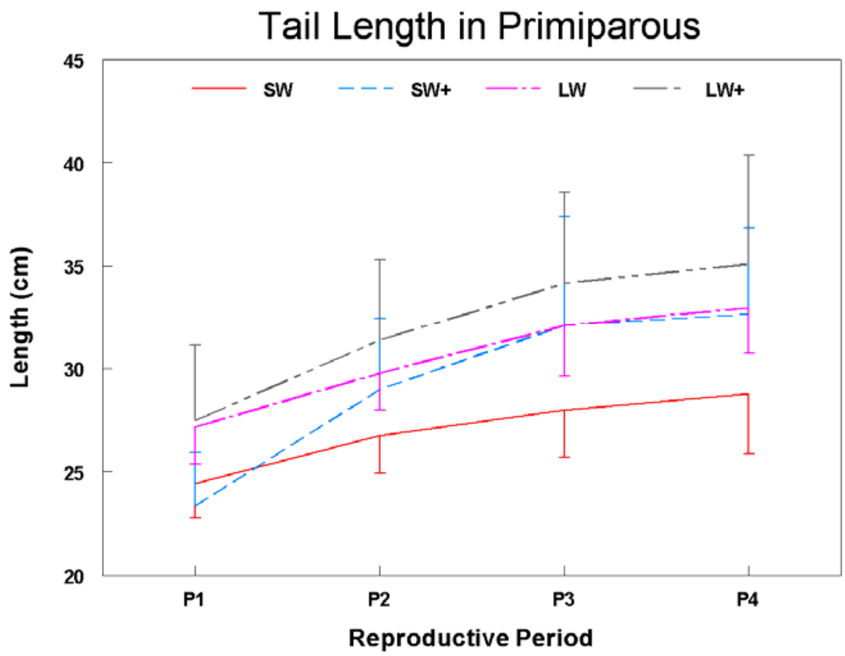

Figure 16. Evolution of tail length for primiparous ewes during the reproductive period

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

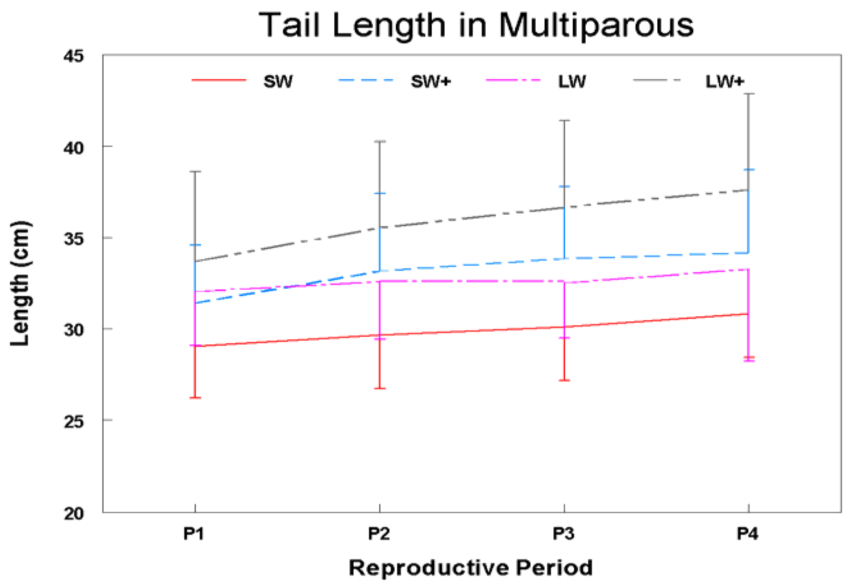

Figure 17. Evolution of tail lenght for multiparous ewes during the reproductive period

lw = large weight;sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

The average values of the Tail circumferences for the various groups of females during the different phases of the reproduction period were subjected to factorial ANOVA analysis (Appendix 8.5).

According to appendix 8.5, the variations on the level of tail circumferences were dependent on three factors age, weight and breeding system. During the two phases P1 and P2, the effects of age and body weight were notable ($p<0.01$). The effect of supplements on the tail circumference came more intense starting from the third phase, P3.

The interaction between the three factors was not significant.

According to tables 15,16, 17 and 18; low weight hoggets (Hsw) of the improved system (Hsw $^{+}$) on average had significant values of tail circumference higher ($p<0.05$) than those of the sw group of the traditional system during the four phases of the reproduction period: P1 (26.11±4.48 vs 24.50±4.57), P2 (28.25±4.31 vs 25.75±4.84), P3 (31.33±3.67 vs 27.72±3.52) and P4 (34.92±3.72 vs 32.88±4.13 cm). Tail circumferences for high weight hoggets (Hlw) of the improved system were not significantly different from those of the traditional system; but this group maintained values significantly higher ($p<0.05$) than those of the low weight group of the traditional and improved system during the first two phases P1 and P2.

Concerning primiparous and multiparous ewes of the low weight and high weight (sw and lw)) groups of the improved system, the average tail circumferences were significantly higher ($p<0.05$) than those of ewes of the traditional system, starting from the second phase, P2, of reproduction phase.

Tail circumferences of hoggets of the improved system did evolve faster evolution than those of hoggets at the traditional system. In addition, primiparous and multiparous ewes of the traditional system did maintain their tail circumferences almost stable during the P3 phase of the reproduction period.

Finally, tail circumferences were higher in primiparous and multiparous ewes than in hoggets, results also obtained by Goodwin (1971) who showed that the quantity of fat which increases with age is initially present in tiny quantities in young sheep and in significant quantities in adult sheep.

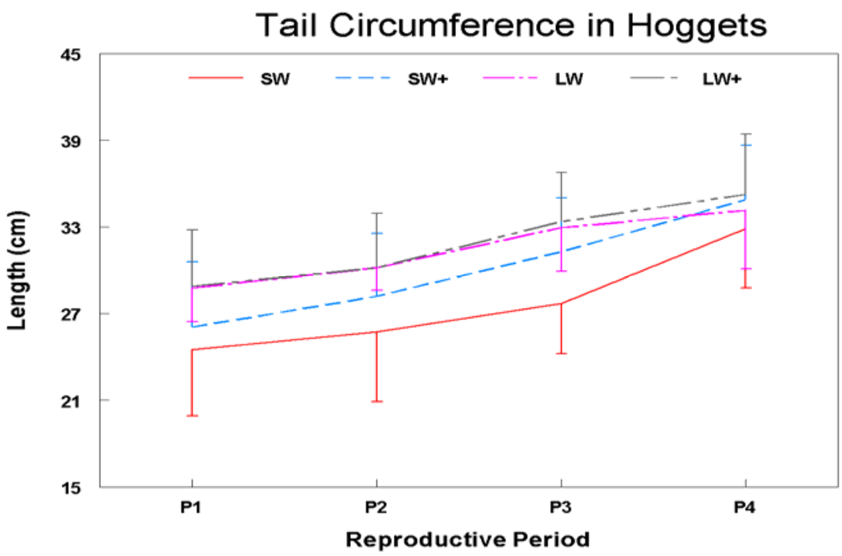

Figure 18. Evolution of tail circumference for hoggets during the reproductive period

lw = large weight; sw = small weight;+ = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

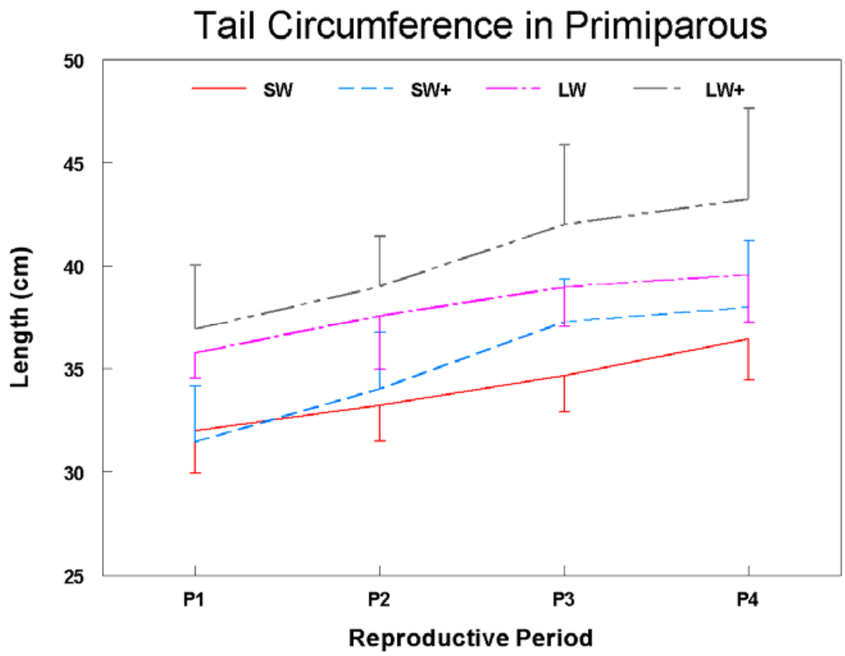

Figure 19. Evolution of tail lenght for primiparous ewes during the reproductive period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

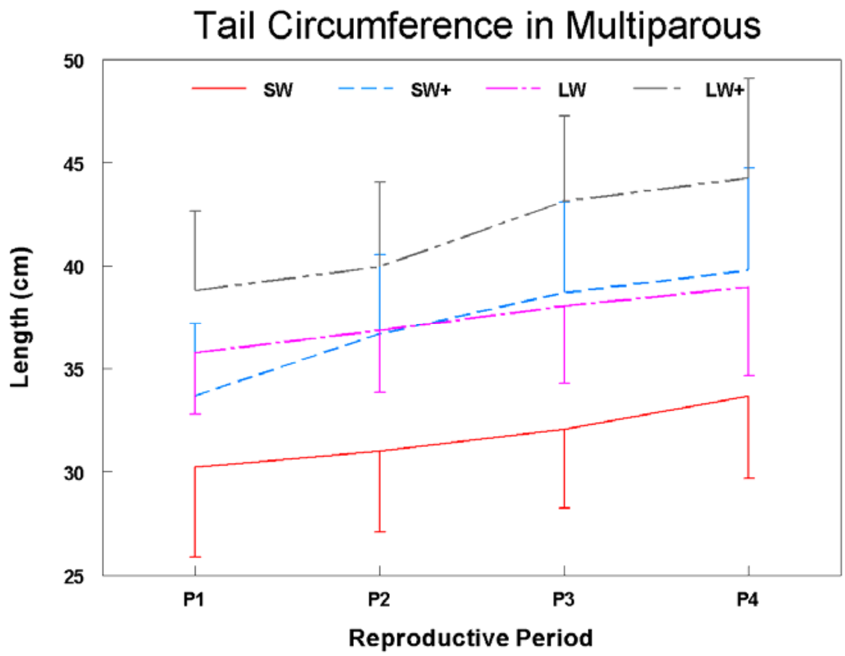

Figure 20. Evolution of tail lenght for multiparous ewes during the reproductive period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

Effects of age group, weight group and management system on tail volumes during the different periods of the reproduction process were analysed using multifactorial ANOVA as shown in Appendix 8.6.

The ANOVA results indicate significant effects of age, weight and management on tail volumes during all periods.

According to tables 15,16, 17 and 18; the tail volumes for low weight hoggets (Hsw) in the improved system was significantly higher ($p<0.05$) than that of hoggets in the traditional system througout four phases of the reproduction period P1 (0.65 ±0.33 vs 0.45±0.24), P2 (0.91±0.26 vs 0.65±0.27), P3 (1.15±0.18 vs 0.89±0.27) and P4 (1.18±0.15 vs 0.91±0.24). As for high weight hoggets of the improved system, their tail volumes were significantly higher ($p<0.05$) than those of the Hlw of the traditional system (1.46 ±0.26 1.04±0.4) during the forth phase, P4, of the reproduction period.

Tail volumes for the large weight primiparous and multiparous ewes of the traditional and improved systems were significantly higher ($p<0.05$) compared to the sw groups of the two systems during phase P1 (primiparous: 1.48±0.36 and 1.53±0.41 vs 1.23±0.22 and 1.18±0.18; multiparous: 1.56±0.23 and 1.77±0.47 vs 1.27±0.19 and 1.51±0.38) for the four groups sw lw+, sw and sw+ respectively and P2 (primiparous: 1.58±0.40 and 1.67±0.16 vs 1.37±0.33 and 1.35±0.33; multiparous: 1.88±0.52 and 1.60±0.24 vs 1.31±0.16 and 1.60±0.32).

During the third phase P3, the primiparous and multiparous ewes of the improved system had significant higher tail volumes ($p<0.05$) that ewes of same age and weight in the traditional mangement system.

The evolution of tail volumes (fig. 21) was marked for Hsw of the improved system compared to those of the traditional system, whereas the high weight hoggets of the two systems (traditional and improved) showed almost similar tail volume values during the first three phases while during the P4 Phase , the high weight hoggets of the traditional system showed a fast decrease of tail volume due to poor pasture sites.

Finally according to Fig.22 and 23, tail volume of primiparous and multiparous did evolve of similar average values during the P1 phase.

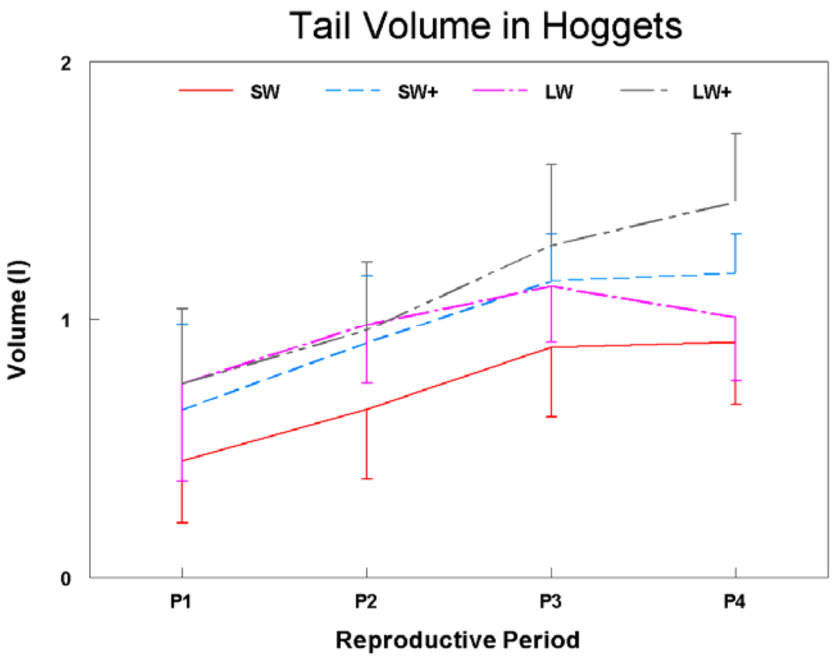

Figure 21. Evolution of tail volume for hoggets during the reproductive period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

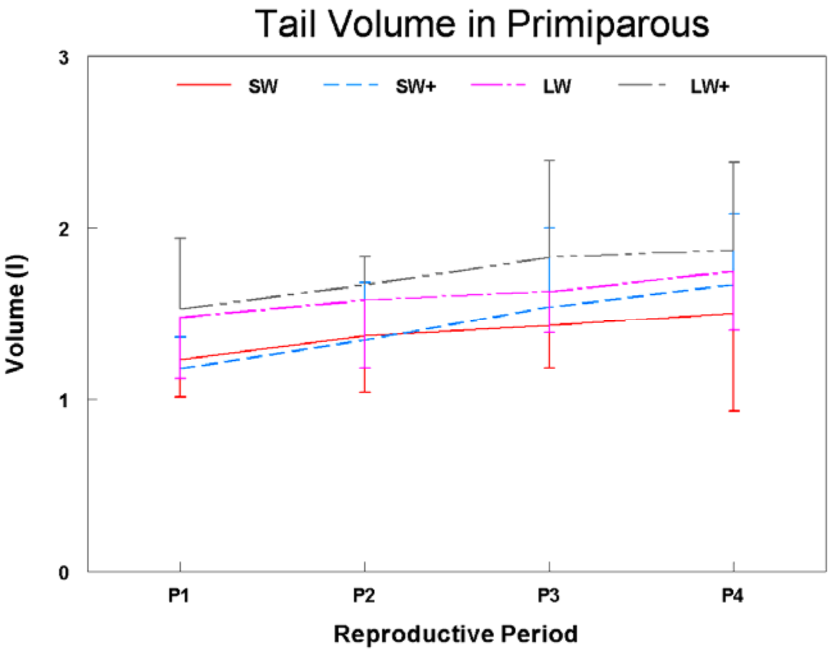

Figure 22. Evolution of tail volume for primiparous ewes during the reproductive period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

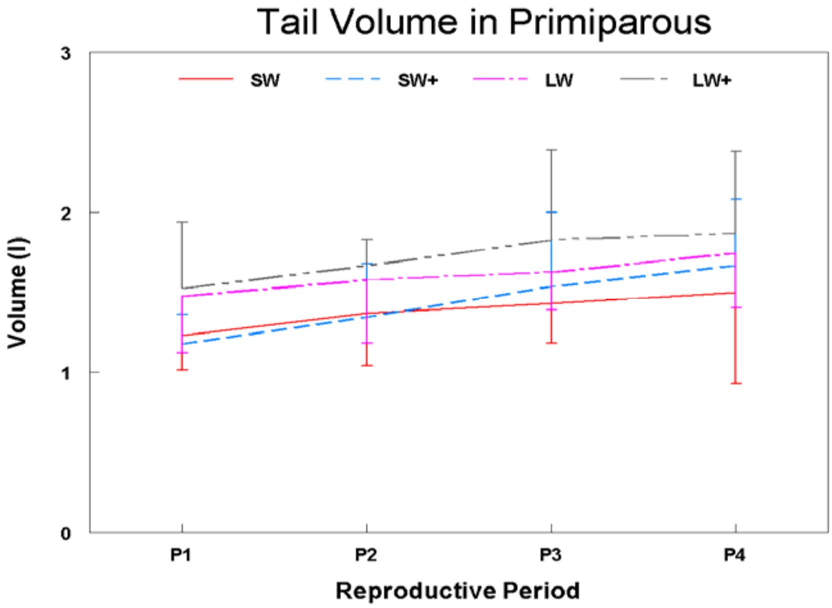

Figure 23. Evolution of tail volume for multiparous ewes during the reproduction period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

4.1.4. Estimates of body condition during the reproduction period

The best way to assess the condition of an animal is to determine if it has the correct weight for its age and physiological stage. However, it is not always possible to weigh an animal on a scale, e.g. under field conditions, in moutainous areas; weighing ewes in advanced pregnancy may also be difficult. Therefore, the body condition score is known as a safe and practical alternative method to assess an animal's condition.

The average body condition score values of the various groups of females with different age, weight, and breeding system during the four phases of reproduction period are contained in table 19, and illustrated in figures 24, 25 and 26.

The variations of the body condition scores (Appendix 8.7) between the various groups did depend on age and body size during the first two phases of the reproduction period; whereas in the third phase, the contribution of supplements was the paramount factor affecting the body condition scores. There was no interaction between these three factors (age, weight, system of breeding) (Appendix 8.7).

Table 19: LS mean of Body condition score of Awassi sheep during the 4 phases of the reproduction period

Age group	Weight group	P1	P2	P3	P4
Hoggets	Hsw	$2.28{\pm}0.57^{a}$	$2.63{\pm}0.49^{a}$	$2.94{\pm}0.24^{a}$	$3.17{\pm}0.41^{a}$
(n=6)	Hsw^{+}	$2.33{\pm}0.59^{a}$	$2.88{\pm}0.45^{ab}$	$3.39{\pm}0.50^{ab}$	$3.33{\pm}0.52^{ab}$
	Hlw	$2.94{\pm}0.24^{b}$	$3.25{\pm}0.44^{b}$	$3.22{\pm}0.43^{ab}$	$3.33{\pm}0.52^{ab}$
	Hlw^{+}	$3{\pm}0.34^{b}$	$3.29{\pm}0.46^{b}$	$3.56{\pm}0.51^{b}$	$3.67{\pm}0.52^{b}$
Total (n=24)		$\mathbf{2.65{\pm}0.56}^{a}$	$\mathbf{3.02{\pm}0.53}^{b}$	$\mathbf{3.29{\pm}0.47}^{b}$	$\mathbf{3.38{\pm}0.49}^{b}$
Primiparous	Psw	$2.52{\pm}0.60^{a}$	$2.86{\pm}0.20^{a}$	$3{\pm}0^{a}$	$3{\pm}0^{a}$
(n=6)	Psw^{+}	$2.50{\pm}0.62^{a}$	$2.92{\pm}0.31^{a}$	$3.11{\pm}0.32^{ab}$	$3.33{\pm}0.82^{ab}$
	Plw	$2.88{\pm}0.34^{ab}$	$3.06{\pm}0^{a}$	$3.08{\pm}0.41^{ab}$	$3{\pm}0.35^{a}$
	Plw^{+}	$3.04{\pm}0.46^{b}$	$3.25{\pm}0.44^{a}$	$3.54{\pm}0.51^{b}$	$3.54{\pm}0.52^{b}$
Total (n=24)		$\mathbf{2.76{\pm}0.56}^{a}$	$\mathbf{3.04{\pm}0.38}^{ab}$	$\mathbf{3.21{\pm}0.43}^{b}$	$\mathbf{3.14{\pm}0.52}^{b}$
Multiparous	Msw	$2.89{\pm}0.68_{a}$	$3.17{\pm}0.48^{a}$	$3.28{\pm}0.46^{a}$	$3.28{\pm}0.52^{a}$
(n=6)	Msw^{+}	$2.89{\pm}0.47^{a}$	$3.42{\pm}0.58^{a}$	$3.67{\pm}0.49^{b}$	$3.67{\pm}0.52^{b}$
	Mlw	$3{\pm}0^{a}$	$3.32{\pm}0.48^{a}$	$3.24{\pm}0.44^{a}$	$3.33{\pm}0.38^{a}$
	Mlw^{+}	$3.13{\pm}0.61^{a}$	$3.44{\pm}0.56^{a}$	$3.75{\pm}0.44^{b}$	$3.63{\pm}0.52^{b}$
Total (n=24)		$\mathbf{2.99{\pm}0.51}^{a}$	$\mathbf{3.35{\pm}0.53}^{ab}$	$\mathbf{3.50{\pm}0.50}^{b}$	$\mathbf{3.30{\pm}0.54}^{ab}$
Management					
Traditional	24	$2.75{\pm}0.40^{a}$	$3.04{\pm}0.34^{a}$	3.12 ± 0.33^{a}	3.18 ± 0.36^{a}
Improved	24	2.79 ± 0.51^{a}	$3.2{\pm}0.46^{a}$	$3.50{\pm}0.46^{a}$	3.52 ± 0.57^{b}

a, b, c: In column, for each group of the animals and each phase, in line, for the total between period, the figures with different exhibitors represent a significant difference with p<0.05.
P1 = first phase: hot phase; P2 = second phase: mating phase; P3 = Third phase: dry phase; P4 = fourth phase: rainfall phase. H = Hoggets; P = Primiparous; M = multiparous; lw = large weight; sw = small weight + = supplemtation

Acording to table 19, the body condition scores during the first phase of reproduction of large weight hoggets of the traditionnal and improved breeding systems (Hlw and Hlw+) were significantly higher ($p<0.05$) than those of low weight hoggets of the two systems (2.94±0.24 and 3±0.34 vs 2.28±0.57 and 2.33±0.59 for the 4 groups respectively). On the third phase (P3), the low weight hoggets of the improved system (Hsw+) showed a higher body condition score ($p<0.05$) compared to low weight hoggets of the traditional system (P3: 3.39±0.05 vs 2.94±0.24). From there , no significant differences were detected between the three groups Hsw^{+}, Hlw and Hlw $^{+}$ during the last three phases of the reproduction period.

As for high weight primiparous ewes (Plw), the body condition score values of the traditional and improved system were significantly higher ($p<0.05$) than those of the respective low weight (sw) groups during first phase, whereas during the third phase, low weight females of the improved system had a body condition score significantly higher ($p<0.05$) than ewes of low weight group in the traditional system. During the P4 phase, the females of the improved system of the two weight groups showed a significantly higher body condition score significantly higher ($p<0.05$) than those of the traditional system.

No significant differences were detected for the four groups of primiparous ewes during the first two phases of the reproduction period. In contrast, during phases P3 and P4, the sw and lw multiparous ewes in the improved system presented higher average values ($p<0.05$) than ewes of the traditional system (P3: 3.67±0.49 and 3.75±0.44 vs 3.28±0.46 and 3.24±0.44; P4: 3.67±0.52 and 3.63±0.52 vs 3.28±0.52 and 3.33±0.38 at the four groups Msw+, Mlw+, Msw and Mlw respectively.

The evolution of the body condition scores , shown in figure 24, are more marked in hoggets of the improved group than those of the traditional groups.

According to the fig. 25 and 26, the BCS of primiparous and multiparous ewes of the traditional system were reduced during the third phase whereas during phase P4, all primiparous and multiparous ewes, regardless of systems shown a notable reduction of their BCS.

Thus, the body condition score varied with the age, weight and husbandry system of the animals. Hoggets showed linear increase with age and females of the improved system had a higher BCS than those in the traditional one. The BCS of multiparous ewes in the traditional system was notably reduced during P3; this reduction could be attributed to the mobilization of fat deposit due to feed shortage, as a response to the physiological state of the female.

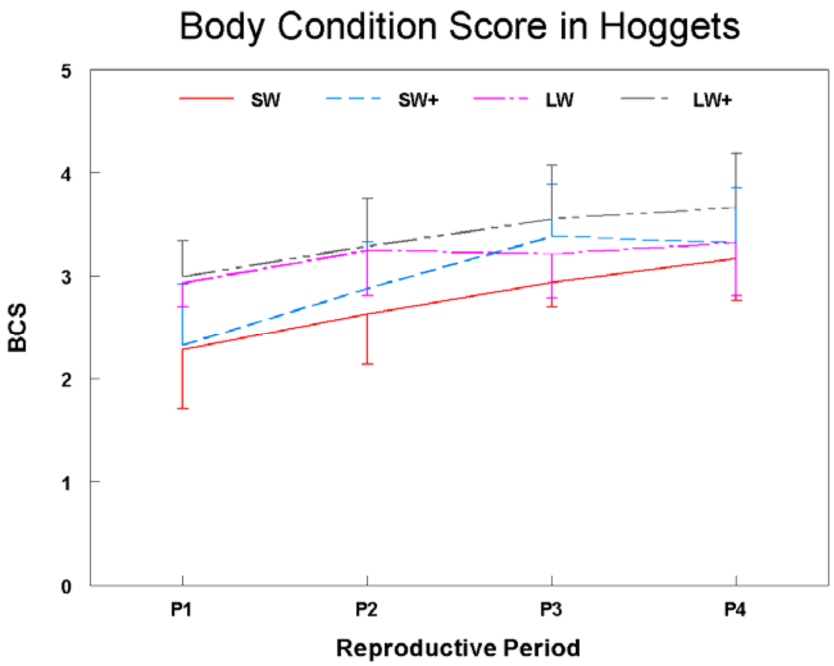

Figure 24. Evolution of body condition scores for hoggets during the reproductive period.

lw = large weight; sw = small weight;+ = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

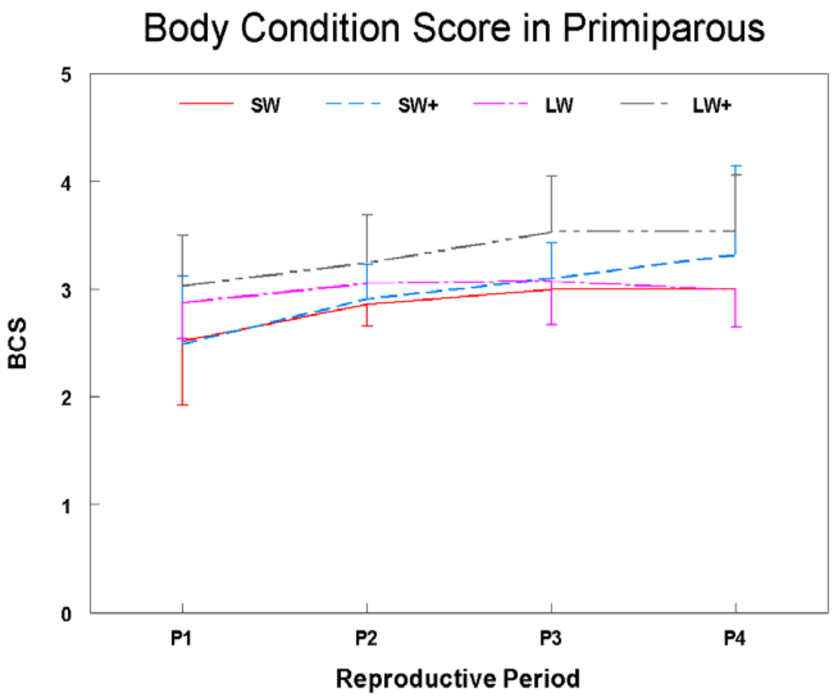

Figure 25. Evolution of body condition score for primiparous ewes during the reproduction period

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

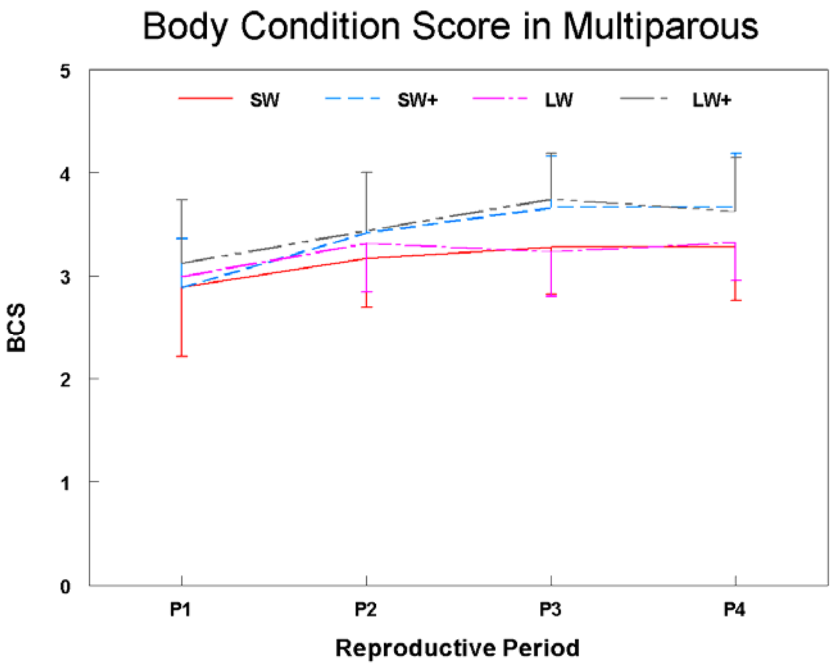

Figure 26. Evolution of body condition score for multiparous during the reproduction period.

lw = large weight; sw = small weight; + = supplementation
P1= first phase of the reproduction period: hot phase;
P2 = second phase of the reproduction period: mating season;
P3 = third phase of the reproduction period: dry period;
P4 = fourth phase of the reproduction period: rainfall season.

4.1.4 Relations between the body condition scores and the various parameters of body and tail growth

Tables 20, 21 and 22 showed the various correlation coefficient estimated for the relationship between body condition score and body and tail measurements for hoggets, primiparous and multiparous ewes during the four phases of the reproduction period.

Table 20: relationship between body condition score and body and tail measurements for hoggets during the experiment
(w = body weight, C = circumference, L = length, V = tail volume)

		Body measurements			Caudal measurements		
		W	C	L	L	C	V
BCS	Hsw	0.96 *	0.97 **	0.96 **	0.95 **	0.96 **	0.96 *
	Hsw +	0.98 *	0.94 **	0.96 **	0.98 **	0.97 **	0.97 *
	Hlw	0.79 *	0.75 **	0.72 **	0.79 **	0.78 **	0.78 *
	Hlw +	0.86 *	0.98 **	0.94 **	0.95 **	0.96 **	0.96 *

* significant at p< 0.05, ** significant at p< 0.01 ; BCS= body condition score

Table 21: relationship between body condition score, and body and tail measurements for primiparous during the experiment
(w = body weight, C = circumference, L = length, V = tail volume)

		Body measurements			Tail measurements		
		W	C	L	L	C	V
BCS	Psw	0.76 **	0.94 **	0.94 **	0.86 **	0.94 **	0.90 **
	Psw +	0.92 **	0.95 **	0.96 **	0.91 **	0.97 **	0.95 **
	Plw	0.77 **	0.82 **	0.77 **	0.53 *	0.77 **	0.71 **
	Plw +	0.98 **	0.95 **	0.96 **	0.96 **	0.97 **	0.97 **

* significant with 0.05, ** significant at 0.01; BCS = body condition score

Table 22: relationship between body condition score, and body and tail measurements for multiparous during the experiment (w = body weight, C = circumference, L = length, V = tail volume)

		Body measurements			Tail measurements		
		W	**C**	**L**	**L**	**C**	**V**
BCS	Mpp	0.81 **	0.83 **	0.86 **	0.77 **	0.87 **	0.83 **
	Mpp +	0.93 **	0.95 **	0.96 **	0.94 **	0.96 **	0.95 **
	Mgp	0.40 *	0.63 *	0.60 *	0.50 *	0.60 *	0.49 *
	Mgp +	0.98 **	0.94 **	0.94 **	0.94 **	0.94 **	0.95 **

* significant with 0.05, ** significant to 0.01; BCS = body condition score

The body condition score was significantly correlated ($p<0.01$) with the various parameters of tail growth. The correlation between body weight and body condition score varied from 0.79 for Hlw to 0.98 for Hsw+. In primiparous ewes, respective correlation varied from 0.76 for Psw to 0.98 for Plw+.

As for multiparous ewes, the correlations between body condition score and tail volume were $r=0.95$ ($p<0.01$) for the two groups Msw+ and Mlw+ and $r=0.83$ ($p<0.01$) and 0.49 ($p<0.05$) for the two groups Msw and Mlw.

4.1.5 Relation between body condition score and fertility of ewes

The effect of the accumulation of the fat reserves on the fertility is reflected by the rate of females in heat (Fig.27), and by the fertility and prolificacy of each group of females.

4.1.5.1 Effects of nutrition and evolution of fatty tail on the release of heat

The evolution of the rate of females in heat starting from the introduction of the males into the herd up to the peak of heat recorded during the study period was shown in figure 27.

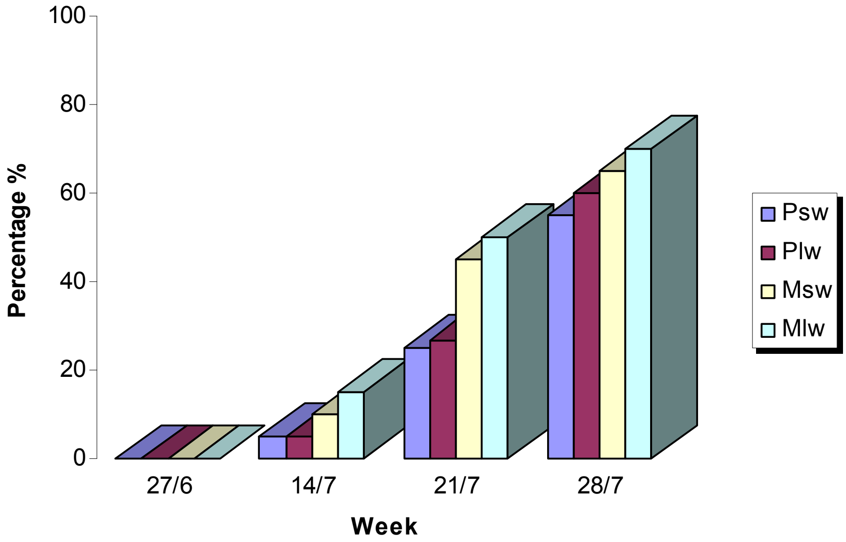

Figure 27. Percentage of the females identified in heat following the introduction of males provided with aprons.

Psw = Primiparous low weight, Plw = Primiparous high weight,

Msw = Multiparous low weight, Mlw= Multiparous high weight

Larger multiparous ewes were the first to express signs of heat, followed by primiparous ewes during the next four weeks (93, 90 for Mlw, Msw, and 87, 80 Plw, Psw).

4.1.5.2 Effects of body condition and tail development on the reproductive performance of Awassi ewes

Fertility and prolificacy of each group of females were recorded from December till the end of March, simultaneously BCS were measured monthly during this period.

Table 23: Fertility, prolificacy and body condition score (mean ±SD)of each group of females

Groups	BCS at parturition	BCS at weaning	Fertility (%)	Prolificacy (%)
Psw ; n = 6	2.55±0.3[a]	2.3±0.2 [a]	44	50
Psw^{+}; n = 6	3.4±0.12[b]	3.4±0.15 [b]	62	80
Plw; n = 6	3±0.35[a]b	2.8±0.37 [a]	50	60
Plw^{+}; n = 6	3.5±0.39[b]	3.6±0.25 [b]	67	75
Msw; n = 6	3.15±0.52[a]	2.9±0.14 [a]	77	85
Msw^{+}; n = 6	3.6±0.39 [b]	3.5±0.27 [b]	83	90
Mlw; n = 6	3.25±0.40[a]	3±0.36 [a]	79	87
Mlw^{+}; n = 6	3.7±0.36 [b]	3.8±0.41 [b]	87	90

Psw = Primiparous low weight, Plw = Primiparous high weight, Msw = Multiparous low weight, Mlw= Multiparous high weight

According to table 23, both fertility and prolificacy were higher in multiparous than in primiparous ewes. Also, the improved group had higher fertility and prolificacy than the groups of the traditional system. In addition, females with highest weights had the best reproductive performances.

Lambing and suckling procedures were accompanied by a regression in BCS of females of the traditionnal system, while in the improved groups, they remained unchanged. These results suggest that the highest energy needs of the females, induced by its physiological state accompanied by food scarcity, do enhance the mobilization of internal fat in the body. Using supplements could be a proper managerial alleviate loss in weight and conditions in these females.

Excess mobilization of fat depots in lactating ewes may have detrimental effects on their welfare and consequently on their reproductive and productive performances. Therefore the quantity and the quality of supplements used have to be adapted to the parturition of the flocks, their productivity and the quality of fourages in the grazing lands. A periodic assessment of BCS of ewes could be a helpful index to estimate the respective nutritive requirements of a flock.

In order to assess the effect of body weight and BCS at mating in both primiparous and multiparous groups on both fertility and prolificacy of ewes, regression lines were dressed (figure 28, 29 and 30) in which body weight at mating were divided into category groups of 3 kg difference, and BCS into 5 groups (from 1 to 5). A note of zero is given for non pregnant females and 1 for pregant ones; besides a note of zero is given to no birth or dead birth; 1 for single birth and 2 for twin birth.

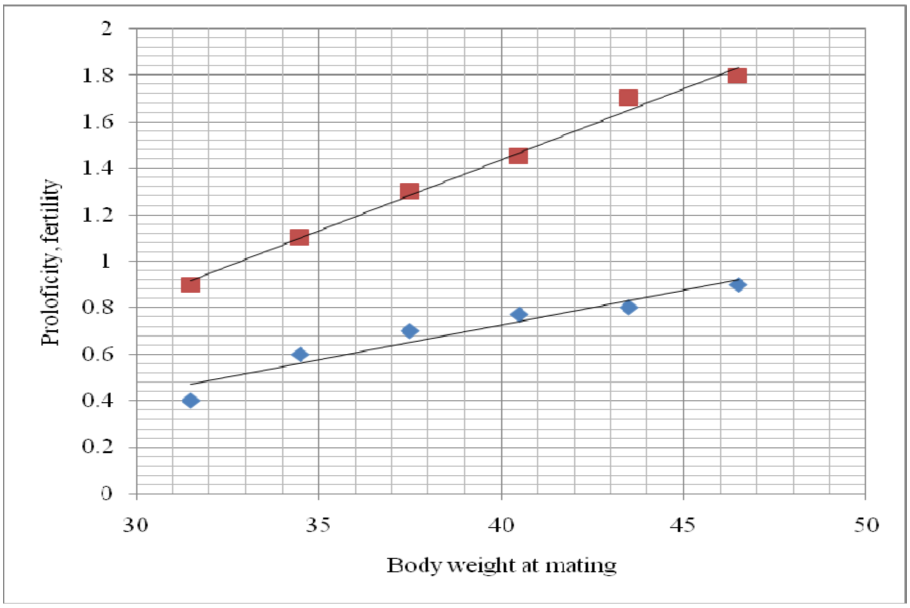

Figure 28. Fertility and prolificicacy of Primiparous according to body weight at mating (3-kg class).

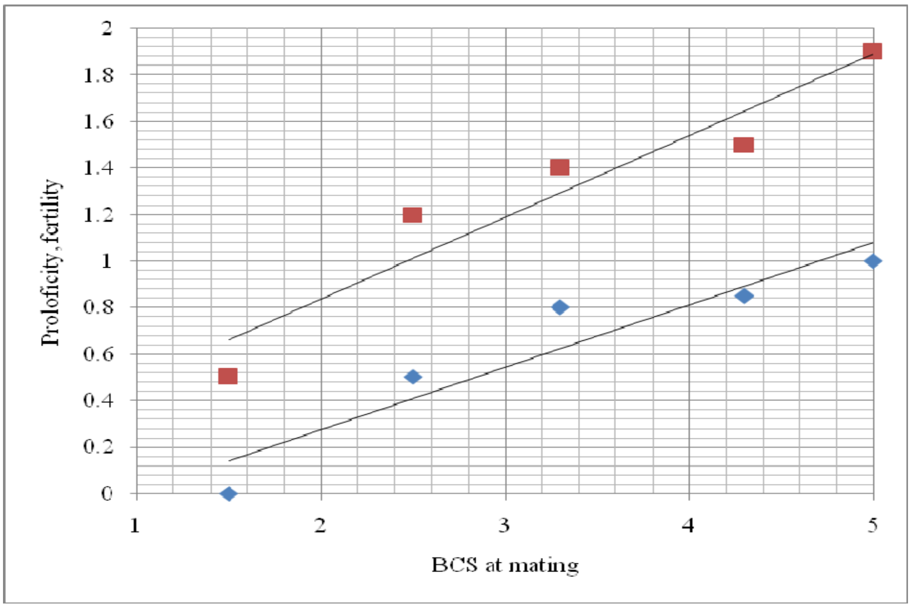

Figure 29. Ewes fertility and prolificacy for primiparous according to BCS at mating.

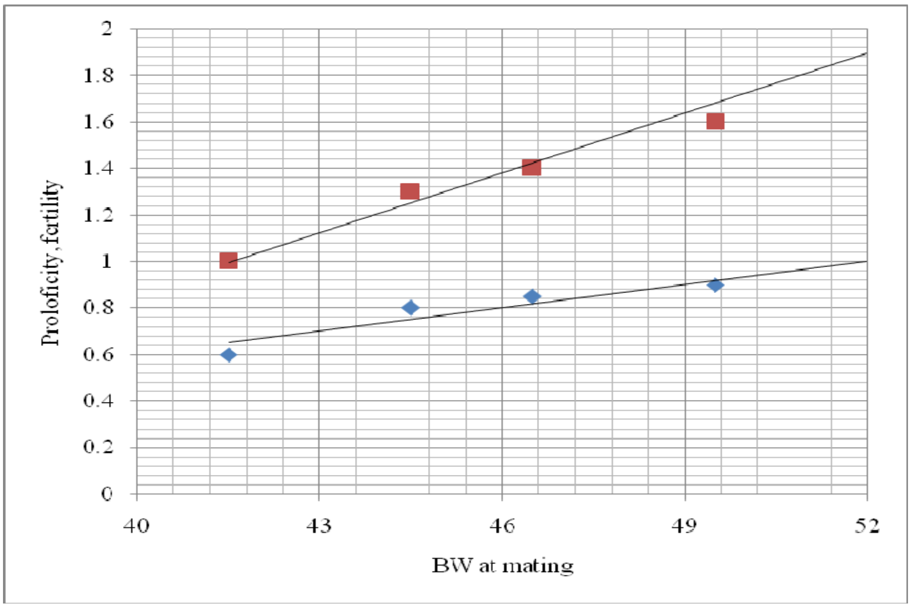

Figure 30. Ewes fertility and prolificacy of multiparous according to body weight at mating.

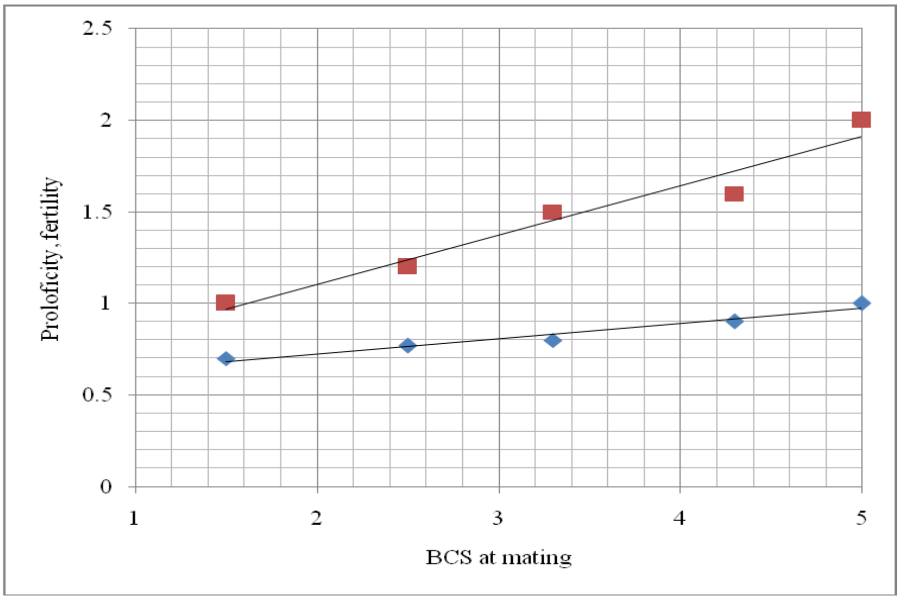

Figure 31. Ewes fertility and prolificacy for multiparous according to BCS at mating.

The fertility and prolificacy of ewes pooled as exposed earlier increased with body weight and body condition score, to reach a maximum value at weight of 40-45 kg in primiparous and 48-52 kgs in multiparous and a body condition score of 4-5 in both primiparous and multiparous

For better clarity of the effects of the various measured parameters of body and tail measurements on the reproductive parameters correlation coefficients were calculated for the data at the end of the P4 phase and reproductive parameters (fertility and prolificacy), as shown in table 24.

Table 24 : Phenotypic relations correlation coefficients between body and tail measurements and reproductive traits

Parameters	**Fertility**	**Prolificacy**
Body measurements		
Age	0.96**	0.95**
Body Weight (kg)	0.97**	0.95**
Body circumference	0..79**	0.75**
Body length	0.68**	0.70**
BCS	0.98**	0.95**
Tail Measurements		
Tail length	0.85**	0.90**
Tail circumference	0.80**	0.75**
Tail volume	0.87**	0.79**

** $p<0.01$

Strong correlations ($p<0.01$) between fertility and prolificacy of ewes a one side and all parameters of body and tail growth on the other side. It was obvious that, as the weight of the females did increase, consequently acquiring more adipose tissue, their fertilily and prolificacy rates increased and did need excess energy and nutrients requirments which are provided either by mobilization of deposited fat if pasture is poor or by supplements if they are used.

4.2 Second experiment

In order to extend the result of the first experiment into the different geographical regions of Lebanon, a second experiment was conducted to study the level of fat deposit (accumulation and mobilization) under different altitudes and climatic conditions and its impact on fertility and prolificacy.

4.2.1 Body growth measurements

The results of ANOVA indicates that the flock and the period (table 25) had no significant effect on body weight. It is only the introduction of supplements that affected significantly the body weight. There is also no interaction between the different parameters.

Table 25: ANOVA test of body weight

Source of variation	DF	SS	MS	
Treatment	7	5850.2	835.74	**
Period	3	465.42	155.14	ns
Flock	4	617.55	154.39	ns
Trt* period	21	3853.7	183.51	ns
Period* flock	28	4897.9	174.92	ns
period* flock	12	2500.6	208.38	ns
Trt* period* flock	84	15872	188.95	ns

** significant at 0.01
*significant at 0.05

Concerning the body condition score (table 26), the results of ANOVA indicates that the 3 factors period, flock and breeding system had significant effect on body condition score ($p<0.01$). There is also interaction between the breeding system and period.

Table 26: ANOVA test of body condition score.

Source of variation	DF	SS	MS	
Treatment	7	40.597	5.7995	**
Period	3	26.107	8.7022	**
Flock	4	43.034	10.758	**
Trt* period	21	28.211	1.3434	**
Period* flock	28	47.727	1.7045	ns
Period* flock	12	26.117	2.1764	ns
Trt* period* flock	84	134.08	1.5962	ns

** significant at 0.01
*significant at 0.05

The average values of body growth parameters (body weight and body condition score) for the various groups of Awassi ewes during the different period of the experiment are presented in tables 27, 28, 29 and 30.

Table 27: Body growth measurements of Awassi ewe during the first period (P1)

	Body weight (kg)±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	34.40±0.33$_a$	34.81±0.17$_a$	34.54±0.46$_a$	34.13±0.83$_a$	34.62±0.17$_a$
Psw+	33.86±0.45$_a$	34.08±0.31$_a$	33.83±0.24$_a$	33.93±0.42$_a$	33.33±0.24$_a$
Plw	41.10±0.79$_b$	41.56±0.33$_b$	41.58±0.36$_b$	41.38±0.27$_b$	41.43±0.33$_b$
Plw+	40.14±0.12$_b$	40.65±0.35$_b$	41.10±0.99$_b$	40.27±0.21$_b$	40.50±0.51$_b$
Msw	41.83±0.62$_b$	42.03±0.55$_b$	42.21±0.63$_b$	41.78±0.31$_b$	41.78±0.57$_b$
Msw+	42.36±0.65$_b$	42.33±0.61$_b$	41.94±0.34$_b$	42.17±0.62$_b$	42.17±0.59$_b$
Mlw	46.26±0.20$_c$	46.31±0.20$_c$	46.83±0.24$_c$	45.31±0.20$_c$	45.31±0.55$_c$
Mlw+	47±0.41$_c$	47.31±0.24$_c$	48±0.41$_c$	46.30±0.24$_c$	46.30±0.24$_c$
Average	**40.86±4.80$_a$**	**41.13±4.74$_a$**	**41.25±5.05$_a$**	**40.28±5.24$_a$**	**40.79±4.69$_a$**
	Body condition score (BCS)				
Psw	2±0.08$_a$	2.52±0.07$_a$	2.18±0.05$_a$	2.08±0.12$_a$	2.12±0.10$_a$
Psw+	2.13±0.02$_a$	2.50±0.14$_a$	2.32±0.04$_a$	2.19±0.06$_a$	2.28±0.05$_a$
Plw	2.24±0.11$_a$	2.88±0.$_a$	2.87±0.01$_{ab}$	2.76±0.01$_b$	2.79±0.01$_b$
Plw+	2.43±0.05$_a$	3.04±0.06$_a$	3.31±0.13$_b$	3.23±0.09$_c$	3.27±0.08$_c$
Msw	2.03±0.05$_a$	2.89±0.08$_a$	2.64±0.27$_{ab}$	2.50±0.25$_{ab}$	2.57±0.30$_b$
Msw+	2.26±0.04$_a$	2.89±0.08$_a$	2.92±0.07$_{ab}$	2.82±0.07$_b$	2.85±0.03$_b$
Mlw	2.28±0.05$_a$	3±0.0$_a$	3.17±0.24$_b$	3.03±0.26$_{bc}$	3.17±0.24$_c$
Mlw+	2.32±0.06$_a$	3.13±0.0$_a$	3.42±0.12$_b$	3.23±0.12$_c$	3.30±0.21$_c$
Average	**2.21±0.15$_a$**	**2.90±0.20$_b$**	**2.95±0.38$_b$**	**2.83±0.38$_b$**	**2.89±0.38$_b$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with p<0.05.

Table 28: Body growth measurements of Awassi ewe during the second period P2

	Body weight (kg)±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	$35.27 \pm 0.19_{a}$	$35.67 \pm 0.38_{a}$	$36.3 \pm 1.60_{a}$	$34.46 \pm 0.49_{a}$	$35.03 \pm 0.68_{a}$
Psw+	$35.69 \pm 0.66_{a}$	$35.86 \pm 0.58_{a}$	$34.91 \pm 0.59_{a}$	$34.85 \pm 0.58_{a}$	$34.72 \pm 0.57_{a}$
Plw	$42.19 \pm 0.60_{b}$	$43.04 \pm 0.41_{b}$	$43.35 \pm 0.25_{b}$	$42 \pm 0.41_{b}$	$42.35 \pm 0.25_{b}$
Plw+	$41.97 \pm 0.60_{b}$	$43.00 \pm 0.64_{b}$	$43.50 \pm 0.41_{b}$	$42 \pm 0.64_{b}$	$42.56 \pm 0.33_{b}$
Msw	$43.65 \pm 0.23_{b}$	$43.58 \pm 0.20_{b}$	$44.77 \pm 0.21_{b}$	$43.47 \pm 0.35_{b}$	$43.21 \pm 0.28_{b}$
Msw+	$44.33 \pm 0.62_{bc}$	$44.58 \pm 0.61_{b}$	$44.73 \pm 1.16_{b}$	$44.14 \pm 0.85_{b}$	$43.79 \pm 0.36_{b}$
Mlw	$46.81 \pm 0.22_{c}$	$47.02 \pm 0.09_{c}$	$48.33 \pm 0.24_{c}$	$45.98 \pm 0.03_{bc}$	$46.02 \pm 0.09_{c}$
Mlw+	$48.45 \pm 0.25_{c}$	$48.75 \pm 0.31_{c}$	$48.94 \pm 0.75_{c}$	$46.22 \pm 1.26_{c}$	$47.65 \pm 0.23_{c}$
Average	**$42.30 \pm 4.74_{a}$**	**$42.69 \pm 4.72_{a}$**	**$43.17 \pm 4.98_{a}$**	**$41.65 \pm 4.59_{a}$**	**$41.92 \pm 4.70_{a}$**
	Body condition score (BCS)				
Psw	$2.15 \pm 0.04_{a}$	$2.81 \pm 0.07_{a}$	$2.81 \pm 0.07_{a}$	$2.72 \pm 0.12_{b}$	$3 \pm 0.0_{a}$
Psw+	$2.28 \pm 0.05_{a}$	$2.89 \pm 0.08_{a}$	$3.47 \pm 0.05_{b}$	$2.93 \pm 0.05_{b}$	$3 \pm 0.0_{a}$
Plw	$2.33 \pm 0.06_{a}$	$3.04 \pm 0.06_{ab}$	$3.18 \pm 0.17_{ab}$	$2.97 \pm 0.05_{b}$	$3.13 \pm 0.00_{ab}$
Plw+	$2.55 \pm 0.07_{a}$	$3.21 \pm 0.06_{b}$	$3.29 \pm 0.16_{b}$	$3.17 \pm 0.24_{c}$	$3.46 \pm 0.06_{b}$
Msw	$2.13 \pm 0.02_{a}$	$3.11 \pm 0.08_{ab}$	$3.18 \pm 0.02_{ab}$	$2.20 \pm 0.04_{a}$	$3.33 \pm 0.0_{b}$
Msw+	$2.33 \pm 0.02_{a}$	$3.33 \pm 0.14_{b}$	$3.47 \pm 0.02_{b}$	$2.81 \pm 0.55_{b}$	$3.67 \pm 0.0_{b}$
Mlw	$2.39 \pm 0.08_{a}$	$3.29 \pm 0.12_{b}$	$3.30 \pm 0.09_{b}$	$2.40 \pm 0.06_{ab}$	$3.33 \pm 0.07_{b}$
Mlw+	$2.39 \pm 0.08_{a}$	$3.38 \pm 0.10_{b}$	$3.55 \pm 0.07_{b}$	$2.58 \pm 0.04_{ab}$	$3.71 \pm 0.06_{b}$
Average	**$2.31 \pm 0.13_{a}$**	**$3.18 \pm 0.17_{b}$**	**$3.35 \pm 0.15_{b}$**	**$3.24 \pm 0.14_{b}$**	**$3.37 \pm 0.16_{b}$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

Table 29: Body growth measurements of Awassi ewe during the first period (P3)

	Body weight (kg)±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	36.54±0.47$_a$	37.55±0.45$_a$	38.67±0.62$_a$	36.08±0.76$_a$	36.83±0.47$_a$
Psw+	35.69±0.52$_a$	37.94±0.48$_a$	37.50±1.08$_a$	36.94±0.48$_a$	37.28±0.21$_a$
Plw	43.67±0.62$_b$	44.67±0.62$_b$	44.67±0.62$_b$	43.33±0.24$_b$	43.83±0.47$_b$
Plw+	44.59±0.80$_b$	45.58±0.85$_b$	45.81±0.86$_b$	44.45±1.11$_b$	44.60±0.82$_b$
Msw	44.48±0.11$_b$	44.67±0.36$_b$	45.22±0.21$_b$	44.39±0.16$_b$	43.66±0.37$_b$
Msw+	46.47±0.24$_{bc}$	46.92±0.69$_{bc}$	46.90±0.94$_b$	45.92±1.28$_b$	45.88±0.70$_b$
Mlw	47.79±0.36$_c$	47.79±0.36$_c$	48.28±0.62$_{bc}$	46.13±0.82$_{bc}$	46.69±0.47$_{bc}$
Mlw+	48.77±0.21$_c$	50.28±0.32$_c$	50.61±0.55$_c$	49.02±0.55$_c$	49.30±0.34$_c$
Average	**42.25±7.65$_a$**	**44.42±4.51$_a$**	**44.71±4.51$_a$**	**42.03±5.03$_a$**	**43.51±4.38$_a$**
	Body condition score (BCS)				
Psw	2.72±0.12$_b$	3±0.0$_a$	3±0.0$_a$	3±0.0$_a$	3.30±0.22$_a$
Psw+	2.93±0.05$_b$	3±0.0$_a$	3.13±0.26$_a$	3.07±0.25$_a$	3.13±0.19$_a$
Plw	2.97±0.05$_b$	3.13±0.0$_a$	3.50±0.0$_{ab}$	3.40±0.0$_b$	3.47±0.05$_{ab}$
Plw+	3.17±0.24$_b$	3.46±0.06$_b$	3.60±0.14$_b$	3.60±0.08$_c$	3.65±0.12$_c$
Msw	2.20±0.04$_a$	3.33±0.0$_b$	3.33±0.0$_{ab}$	3.23±0.0$_{ab}$	3.33±0.09$_a$
Msw+	2.81±0.55$_b$	3.67±0.0$_c$	3.61±0.08$_b$	3.55±0.03$_c$	3.66±0.10$_b$
Mlw	2.40±0.06$_b$	3.33±0.07$_b$	3.50±0.0$_{ab}$	3.45±0.0$_b$	3.45±0.0$_{ab}$
Mlw+	2.58±0.04$_b$	3.71±0.06$_c$	3.71±0.06$_b$	3.51±0.04$_c$	3.58±0.13$_c$
Average	**2.72±0.32$_a$**	**3.38±0.26$_b$**	**3.48±0.19$_b$**	**3.40±0.19$_b$**	**3.47±0.19$_b$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

Table 30: Body growth measurements of Awassi ewe during the first period (P4)

	Body weight (kg)±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	38±0.50$_a$	39.00±0.50 $_a$	40±0.00$_a$	38±0.50 $_a$	38±0.50 $_a$
Psw+	38.67±0.33 $_a$	39.67±0.33 $_a$	39.67±0.33 $_a$	38.67±0.33 $_a$	38.67±0.33 $_a$
Plw	44.78±0.22 $_b$	45.78±0.22 $_b$	45.78±0.22 $_b$	44.45±0.24 $_b$	40.28±4.72 $_{ab}$
Plw+	46.50±0.0 $_b$	48.00±0.25 $_b$	48.50±0.50 $_b$	46.46±0.21 $_b$	46.95±0.30 $_b$
Msw	45.05±0.11 $_b$	46.21±0.04 $_b$	47.25±0.25 $_b$	45.21±0.04 $_b$	45.22±0.04 $_b$
Msw+	48.25±0.24 $_{bc}$	49.62±0.46 $_{bc}$	49.75±1.25 $_b$	48.63±0.45$_b$	48.63±0.45 $_{bc}$
Mlw	48.20±0.36 $_c$	49.75±0.46 $_{bc}$	50.25±0.75 $_{bc}$	48.75±0.46 $_b$	48.75±0.46 $_{bc}$
Mlw+	49.60±0.21 $_c$	51.50±0.83 $_c$	52±1.00 $_c$	49.42±0.09 $_b$	50±0.33 $_c$
Average	**44.88±4.36$_a$**	**46.19±4.63 $_a$**	**46.65±4.61 $_a$**	**44.93±4.45 $_a$**	**44.56±4.87 $_a$**
	Body condition score (BCS)				
Psw	2.50±0.0$_b$	3±0.0 $_a$	2.75±0.25 $_a$	2.70±0.30 $_a$	2.68±0.23 $_a$
Psw+	2.75±0.05 $_c$	3.33±0.0 $_b$	2.75±0.05 $_a$	2.73±0.08 $_a$	2.80±0.05 $_a$
Plw	2.79±0.09 $_c$	2.94±0.06 $_a$	2.94±0.06 $_b$	2.85±0.15 $_a$	3.15±0.35 $_b$
Plw+	3.00±0.00 $_d$	3.50±0.12 $_b$	3.50±0.12 $_c$	3.35±0.07 $_c$	3.50±0.00 $_c$
Msw	2.25±0.08 $_a$	3.25±0.08$_b$	3.25±0.08 $_c$	3.07±0.06 $_b$	3.03±0.13 $_b$
Msw+	2.45±0.12 $_b$	3.50±0.17$_c$	3.50±0.17 $_c$	3.40±0.17 $_c$	3.08±0.07 $_b$
Mlw	2.68±0.18 $_c$	3.±0.14 $_a$	3.00±0.14 $_b$	2.85±0.12 $_a$	2.68±0.23 $_a$
Mlw+	2.40±0.10 $_b$	3.69±0.06 $_d$	3.58±0.07 $_c$	3.35±0.07 $_c$	3.10±0.10 $_b$
Average	**2.60±0.24$_a$**	**3.32±0.27 $_b$**	**3.22±0.32 $_b$**	**3.09±0.28 $_{ab}$**	**3.05±0.26 $_{ab}$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

According to tables 27, 28, 29 and 30; the trends of evolution of body weight is nearly similar for the 5 flocks of the study. Even though these flocks were from different geographical regions, they had never shown a significant difference in their body weight throughout the 4 periods of the experiment. However, flock 1 (raised in the mountaineous regions of Mount Lebanon) and flock 5 (raised in South Lebanon) showed the lowest values of body weight throughout the experiment. The highest values were reported for flock 3 raised at Bekaa valley followed by flock 2 raised at the valley of Akkar. Throughout the experiment, large weight females for all groups and all flocks kept a significant difference with small weight females ($p<0.05$); although no significant difference in body weight was noticed between improved and traditionnal system; females of improved system showed higher values of body weight throughout the experiment.

According to table 27, body condition score is more related to the body weight than to the age of the females. Indeed, no significant difference was reported between multiparous and primiparous of the same body weight group. For the flock 1 (Mount Lebanon) and flock 2 (Akkar) all groups of females showed no significant difference in their body condition score ($p>0.05$) during this period.

For the flock 3 (Baalbeck), the primiparous LW showed a higher body condition score than those of SW during this period, at the same time, females of improved system showed a higher body condition score than those of traditionnal system (2.18±0.05; 2.32±0.04; 2.87±0.01; 3.31±0.13 for the 4 groups PSW, PSW+, PLW, PLW+ respectively). For multiparous of flock 3, no siginificant difference was reported between all groups of females during this period.

For the flock 4 (Hermel), Both primiparous and multiparous of LW showed a higher body condition score than SW weight female during this period. The adoption of supplements showed no significant effect on body conditon score and no significant difference were reported between all groups of females. The reported values of body condition score were (2.08±0.12; 2.19±0.06; 2.76±0.01; 3.23±0.09 for the 4 groups Psw, Psw+, Msw and Msw+of primiparous respectively) and (2.50±0.25; 2.82±0.07; 3.03±0.26 and 3.231±0.12 for the 4 groups of multiparous). The same differences were reproted for flock 5 (South Lebanon).

Finally, females of Mount Lebanon showed the lowest values of body condition score (2.21±0.15). No significant difference was reported between all the remaining flocks.

According to table 28; all groups of females in the flock 1 showed no significant difference in their body condition score during P2 period. The primiparous of LW of the flock 2 showed higher body condition score values than those of SW (2.81±0.07; 2.08±0.08; 3.04±0.06 and 3.21±0.06 for the 4 groups Psw, Psw+, Plw, Plw+ respectively). For the flock 3; the Psw+ showed a higher body condition score than Psw (3.47±0.05 vs 2.81±0.07). For the flock 4; both Plw+ and Msw+ showed higher values of body condition score than Plw and Msw respectively (3.17±0.24 vs 2.97±0.05 and 2.81±0.55 vs 2.20±0.04). For flock 5, Plw showed higher values of body condition score than Psw (3±0; 3±0; 3.13±0; 3.46±0.06 for the 4 groups Psw, Psw+, Plw and Plw+ respectively). Flock 1 showed the lowest values of body condition score during this period.

According to table 29, the three flocks 2, 4 and 5 showed higher values of body condition score for the improved system than for the traditionnal system. The reported values for flock 2 were 3.46±0.06 vs 3.13±0 (Plw+ vs Plw); 3.67±0 vs 3.33±0 (Msw+ vs Msw) and 3.71±0.06 vs 3.33±0 (Mlw+ vs Mlw). For flock 1, only the Msw+ showed higher values of body condition score than Msw (2.81±0.55 vs 2.20±0.04). The effect of suplements on body condition score of flock 3 was not significant.

According to table 30, all flocks of the study showed higher values of body condition score for the improved system than for traditionnal ones during the period P4 of the experiment. At the same time, these flocks showed an obvious reduction in their body condition score from period 4 to period 5. The reported data for period 4 vs period 5 were 2.72±0.32 vs 2.60±0.24 for flock 1, 3.38±0.26 vs 3.32±0.27 for flock 2, 3.48±0.19 vs 3.22±0.32 for flock 3; 3.40±0.19 vs 3.09±0.28 for flock 4; and finally 3.47±0.19 vs 3.05±0.26 for flock 5).

4.2.2 Tail measurement

The results of ANOVA (tables 31 and 32) indicate that flock, period and breeding system had significant effect on tail length and circumference; there is also interaction between breeding system and period.

Table 31: ANOVA test of the tail length.

Source of variation	DF	SS	MS	
Treatment	7	3082.2	440.31	**
Period	3	1050.3	350.1	**
Flock	4	22.536	5.6341	**
Trt* period	21	580.44	27.64	**
Period* flock	28	49.023	1.7508	ns
period* flock	12	17.704	1.4753	ns
Trt* period* flock	84	117.25	1.2959	ns

** significant at 0.01;*significant at 0.05

Table 32: ANOVA test of the tail circumference.

Source of variation	DF	SS	MS	
Treatment	7	4056.4	579.48	**
Period	3	955.07	318.36	**
Flock	4	59.202	14801	**
Trt* period	21	244.12	11.625	**
Period* flock	28	98.679	3.5243	ns
period* flock	12	35.02	2.9183	ns
Trt* period* flock	84	299.73	3.5682	Ns

** significant at 0.01; *significant at 0.05

The average values of the tail measurements represented by length, circumference are presented in tables 33, 34, 35 and 36.

Table 33: Tail measurements (length and circumference) of Awassi ewe during P1 period

	Tail length (cm)±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	$23.61 \pm 0.28_a$	$24.43 \pm 0.82_a$	$23.83 \pm 0.24_a$	$23.40 \pm 0.05_a$	$24.43 \pm 0.82_a$
Psw+	$22.44 \pm 1.16_a$	$23.39 \pm 1.23_a$	$23.54 \pm 1.17_a$	$23.55 \pm 1.23_a$	$23.39 \pm 1.23_a$
Plw	$25.50 \pm 0.35_b$	$27.19 \pm 0.74_b$	$27.42 \pm 0.92_b$	$27.54 \pm 0.84_b$	$27.19 \pm 0.74_b$
Plw+	$27.18 \pm 1.75_c$	$27.52 \pm 0.88_b$	$27.61 \pm 0.44_b$	$27.33 \pm 0.66_b$	$27.52 \pm 0.88_b$
Msw	$28.39 \pm 0.08_c$	$29.06 \pm 0.39_b$	$29.30 \pm 0.28_c$	$28.67 \pm 0.47_b$	$29.06 \pm 0.39_b$
Msw+	$31.43 \pm 1.02_d$	$31.44 \pm 1.04_c$	$32.28 \pm 1.17_d$	$31.44 \pm 1.04_c$	$31.44 \pm 1.04_c$
Mlw	$31.83 \pm 0.24_d$	$32.05 \pm 0.55_{cd}$	$32.33 \pm 0.62_d$	$32.05 \pm 0.55_{cd}$	$32.05 \pm 0.55_{cd}$
Mlw+	$33.67 \pm 0.62_e$	$33.72 \pm 0.77_d$	$33.76 \pm 0.81_d$	$33.72 \pm 0.77_d$	$33.72 \pm 0.77_d$
Average	$\mathbf{28.01 \pm 4.07_a}$	$\mathbf{28.60 \pm 3.67_a}$	$\mathbf{28.76 \pm 3.87_a}$	$\mathbf{28.46 \pm 3.80_a}$	$\mathbf{28.60 \pm 3.67_a}$
	Tail circumference (cm)±SE				
Psw	$31.33 \pm 0.14_a$	$32 \pm 0.42_a$	$32.53 \pm 0.09_a$	$31.78 \pm 0.32_a$	$31.78 \pm 0.57_a$
Psw+	$30.50 \pm 0.82_a$	$31.50 \pm 0.82_a$	$31.95 \pm 0.41_a$	$31.87 \pm 0.66_a$	$31.50 \pm 0.82_a$
Plw	$34.78 \pm 0.43_c$	$35.78 \pm 0.43_c$	$35.86 \pm 0.35_c$	$35.43 \pm 0.42_c$	$35.44 \pm 0.19_c$
Plw+	$35.95 \pm 1.29_c$	$36.94 \pm 1.29_{cd}$	$37.42 \pm 1.01_d$	$37.17 \pm 0.85_d$	$36.79 \pm 1.15_c$
Msw	$29.22 \pm 0.42_a$	30.22±0.42a	$31 \pm 0.72_a$	$30.33 \pm 0.47_a$	$30.28 \pm 0.21_a$
Msw+	$32.72 \pm 1.26_b$	$33.72 \pm 1.26_b$	$33.94 \pm 1.46_b$	$33.78 \pm 1.22_b$	$33.61 \pm 0.98_b$
Mlw	$34.86 \pm 0.31_c$	$35.81 \pm 0.24_c$	$35.93 \pm 0.41_c$	$35.50 \pm 0.41_c$	$35.93 \pm 0.35_c$
Mlw+	$37.84 \pm 0.39_d$	$38.83 \pm 0.39_d$	$38.90 \pm 0.40_d$	$38.96 \pm 0.36_d$	$38.57 \pm 0.49_d$
Average	$\mathbf{33.69 \pm 3.05_a}$	$\mathbf{34.69 \pm 3.05_a}$	$\mathbf{35 \pm 2.86_a}$	$\mathbf{34.72 \pm 2.98_a}$	$\mathbf{34.59 \pm 2.95_a}$

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

Table 34: Tail measurements (length and circumference) of Awassi ewe during P2 period

	Tail length (cm)±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	$25.91\pm0.68_{a}$	$26.57\pm0.23_{a}$	$26.73\pm0.17_{a}$	$25.85\pm0.50_{a}$	$26.57\pm0.23_{a}$
Psw+	$26.91\pm0.97_{a}$	$28.28\pm1.29_{a}$	$28.50\pm1.22_{a}$	$28.43\pm1.39_{a}$	$28.28\pm1.29_{a}$
Plw	$28.48\pm0.41_{ab}$	$29.48\pm0.41_{ab}$	$30.07\pm0.66_{ab}$	$29.51\pm0.43_{a}$	$29.48\pm0.41_{b}$
Plw+	$29.95\pm0.82_{b}$	$30.95\pm0.82_{b}$	$31.12\pm1.01_{b}$	$30.56\pm0.88_{ab}$	$30.95\pm0.82_{b}$
Msw	$28.56\pm0.16_{b}$	$29.56\pm0.16_{ab}$	$28.72\pm0.55_{a}$	$29\pm0.0_{a}$	$29.56\pm0.16_{b}$
Msw+	$32.23\pm0.56_{c}$	$33.17\pm0.14_{c}$	$33.67\pm0.47_{cd}$	$33.17\pm0.24_{c}$	$33.17\pm0.14_{c}$
Mlw	$32.49\pm0.16_{c}$	$32.52\pm0.13_{bc}$	$32.33\pm0.08_{c}$	$32.29\pm0.20_{bc}$	$32.52\pm0.13_{c}$
Mlw+	$34.67\pm0.47_{d}$	$35.31\pm0.37_{d}$	$34.64\pm0.23_{d}$	$35.06\pm0.21_{d}$	$35.31\pm0.37_{d}$
Average	$\mathbf{29.90\pm3.01_{a}}$	$\mathbf{30.73\pm2.84_{a}}$	$\mathbf{30.72\pm2.73_{a}}$	$\mathbf{30.48\pm2.93_{a}}$	$\mathbf{30.73\pm2.84_{a}}$
	Tail circumference (cm)±SE				
Psw	$32.14\pm0.38_{b}$	$33.14\pm0.38_{b}$	$33.44\pm0.42_{a}$	$32.34\pm0.30_{ab}$	$32.72\pm0.35_{a}$
Psw+	$32.50\pm1.09_{b}$	$33.50\pm1.09_{b}$	$33.71\pm1.15_{a}$	$33.61\pm1.17_{b}$	$34.00\pm1_{b}$
Plw	$36.37\pm0.67_{c}$	$37.37\pm0.67_{c}$	$37.50\pm0.73_{b}$	$37.08\pm0.52_{c}$	$36.72\pm0.95_{c}$
Plw+	$37.86\pm0.27_{d}$	$38.78\pm0.35_{d}$	$39.13\pm0.55_{c}$	$39.38\pm1.41_{d}$	$38.06\pm0.10_{d}$
Msw	$29.78\pm0.39_{a}$	30.94±0.10a	$32.11\pm0.35_{a}$	$31.42\pm0.14_{a}$	$31.11\pm0.35_{a}$
Msw+	$35.39\pm0.79_{c}$	36.39±0.79c	$36.72\pm0.75_{b}$	$36.39\pm0.35_{c}$	$35.72\pm0.75_{bc}$
Mlw	$35.71\pm0.43_{c}$	$36.71\pm0.43_{c}$	$36.84\pm0.35_{b}$	$36.50\pm0.50_{c}$	$36.51\pm0.32_{c}$
Mlw+	$38.71\pm0.14_{d}$	$39.71\pm0.14_{d}$	$39.71\pm0.26_{c}$	$39.71\pm0.26_{d}$	$39.63\pm0.22_{d}$
Average	$\mathbf{35.19\pm3.10_{a}}$	$\mathbf{36.20\pm3.04_{a}}$	$\mathbf{36.53\pm2.75_{a}}$	$\mathbf{36.30\pm2.97_{a}}$	$\mathbf{35.96\pm2.77_{a}}$

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

Table 35: Tail measurements (length and circumference) of Awassi ewe during P3 period

	Tail length (cm)±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	27.68±1.00$_{a}$	27.62±0.37$_{a}$	28.50±0.17$_{a}$	26.79±0.50$_{a}$	27.62±0.37$_{a}$
Psw+	31.19±0.86$_{b}$	31.61±0.34$_{b}$	31.78±0.47$_{b}$	31.77±0.42$_{ab}$	31.61±0.34$_{ab}$
Plw	30.58±1.01$_{b}$	31.42±0.51$_{b}$	31.83±0.62$_{b}$	31.07±0.33$_{ab}$	31.42±0.51$_{ab}$
Plw+	32.05±1.69$_{b}$	33.43±0.43$_{b}$	33.70±0.65$_{bc}$	33.38±0.41$_{b}$	33.43±0.58$_{b}$
Msw	29.17±0.13$_{ab}$	30.17±0.14$_{ab}$	29.17±0.13$_{a}$	30±0.0$_{ab}$	30.17±0.14$_{a}$
Msw+	32.53±0.26$_{bc}$	33.53±0.26$_{b}$	34.47±0.17$_{c}$	33.±0.0$_{b}$	33.53±0.26$_{b}$
Mlw	32.95±0.07$_{bc}$	32.81±0.18$_{b}$	32.35±0.32$_{bc}$	32.81±0.18$_{b}$	32.81±0.18$_{b}$
Mlw+	35.47±0.14$_{c}$	36.47±0.14$_{c}$	36.14±0.33$_{c}$	36.14±0.20$_{c}$	36.47±0.14$_{c}$
Average	**31.45±2.40$_{a}$**	**32.13±2.62$_{a}$**	**31.15±5.05$_{a}$**	**31.87±2.74$_{a}$**	**32.13±2.62$_{a}$**
	Tail circumference (cm)±SE				
Psw	33.37±0.50$_{a}$	34.33±0.50$_{b}$	34.22±0.33$_{b}$	33.69±0.39$_{b}$	34.03±0.41$_{b}$
Psw+	35.58±0.78$_{b}$	36.56±0.84$_{c}$	36.07±0.60$_{c}$	36.30±0.66$_{c}$	36.64±0.81$_{c}$
Plw	37.62±0.36$_{c}$	38.62±0.36$_{d}$	38.85±0.61$_{d}$	38.42±0.38$_{d}$	37.62±0.36$_{c}$
Plw+	39.94±1.34$_{d}$	40.98±1.33$_{e}$	41.34±1.71$_{e}$	41.08±1.63$_{e}$	40.31±1.34$_{d}$
Msw	30.61±0.42$_{a}$	31.61±0.42a	32.45±0.25$_{a}$	31.81±0.64$_{a}$	31.72±0.25$_{a}$
Msw+	37.11±0.42$_{c}$	38.11±0.42d	38.23±0.25$_{d}$	37.61±0.42$_{c}$	37.55±0.43$_{c}$
Mlw	36.68±0.29$_{bc}$	37.71±0.29$_{d}$	37.75±0.25$_{cd}$	37.55±0.09$_{c}$	37.30±0.27$_{c}$
Mlw+	38.34±6.57$_{cd}$	42.04±1.26$_{f}$	42.17±1.26$_{d}$	41.75±0.66$_{e}$	42.13±1$_{d}$
Average	**36.55±2.95$_{a}$**	**37.95±3.38$_{a}$**	**38.12±3.26$_{a}$**	**37.79±3.29$_{a}$**	**37.61±3.25$_{a}$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

Table 36: Tail measurements (length and circumference) of Awassi ewe during P4

	Tail length (cm)±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	28.65±0.21$_a$	28.61±0.26 $_a$	28.68±0.16$_a$	27.47±0.26 $_a$	28.61±0.26 $_a$
Psw+	32.50±0.00 $_b$	32.67±0.00 $_b$	32.55±0.07 $_b$	31.55±0.07 $_b$	32.67±0.00 $_{ab}$
Plw	32.64±0.20 $_b$	32.94±0.09 $_b$	33.25±0.35 $_{bc}$	32.44±0.62 $_b$	32.94±0.09 $_{ab}$
Plw+	35.45±1.34 $_c$	35.07±0.10 $_c$	35.50±0.00 $_{bc}$	34.35±0.49 $_{bc}$	35.07±0.10 $_b$
Msw	29.08±1.06 $_a$	30.33±0.70 $_b$	29.33±0.71 $_a$	29.50±0.71 $_a$	30.33±0.70 $_{ab}$
Msw+	33.17±0.00 $_b$	34.17±0.00 $_{bc}$	33.59±0.59 $_{bc}$	34±0.0$_{bc}$	34.17±0.00 $_{bc}$
Mlw	33±0.71 $_b$	32.65±0.91 $_b$	31.90±0.56 $_{bc}$	32.75±1.06 $_b$	32.65±0.91 $_b$
Mlw+	36.34±0.47 $_c$	37.34±0.47 $_c$	36.30±0.42$_c$	37.25±0.35 $_c$	37.34±0.47 $_c$
Average	**32.60±2.69$_a$**	**32.97±2.70 $_a$**	**32.64±2.67 $_a$**	**32.41±3.01 $_a$**	**32.97±2.70 $_a$**
	Tail circumference (cm)±SE				
Psw	34.65±1.11$_a$	35.64±1.11 $_a$	36.52±0.03 $_b$	34.20±0.99 $_a$	34.84±0.83 $_a$
Psw+	36.92±0.12 $_b$	37.92±0.12 $_b$	37.75±0.35 $_b$	37.67±0.23 $_b$	37.38±0.18 $_b$
Plw	38.50±0.10 $_c$	39.50±0.10 $_b$	39.56±0.02 $_c$	39.25±0.35 $_b$	39±0.81 $_b$
Plw+	42.15±0.21 $_d$	43.15±0.21 $_c$	43.40±0.15 $_d$	42.92±0.12 $_c$	42.90±0.56 $_c$
Msw	32.09±0.83 $_a$	33.09±0.83a	33.56±0.03 $_a$	33.17±0.47 $_a$	33±0.71 $_a$
Msw+	38.67±0.23 $_c$	39.67±0.23b	39.79±0.06$_c$	38.50±0.00 $_b$	38.67±0.23 $_b$
Mlw	37.75±0.35 $_{bc}$	38.75±0.35 $_b$	39.00±0.71 $_c$	38.25±0.35 $_b$	38.25±0.35 $_b$
Mlw+	43.18±0.11 $_d$	44.28±0.04 $_c$	44.42±0.12 $_d$	42.91±0.75 $_c$	43.92±0.12 $_c$
Average	**38.46±3.64$_a$**	**39.48±3.66 $_a$**	**37.50±8.68 $_a$**	**38.95±3.35 $_a$**	**39.01±3.62 $_a$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with p<0.05.

According to tables 33, 34, 35 and 36; all groups of primiparous for all groups of flocks showed no significant difference in their tail length ($p>0.05$) during the 4 periods of the experiment. Multiparous of improved system both lw and sw (Msw+ and Mlw+) showed higher values of tail length than multiparous sw and lw for all groups of flocks and for all periods of the experiments.

Concerning tail circumference, all groups of females both multiparous and primiparous sw and lw of the improved system showed higher values of tail circumference than those of traditionnal system for the 4 periods of the experiments and for all groups of flocks.

The results of ANOVA (table 37) indicate that the flock, the period and the breeding system had significant effect on tail volume.

Table 37: ANOVA test of the tail length.

Source of variation	DF	SS	MS	
Treatment	7	13.469	1.9242	**
Period	3	1.8178	0.6059	**
Flock	4	0.8636	0.2159	**
Trt* period	21	0.6859	0.0327	**
Period* flock	28	0.2517	0.009	NS
period* flock	12	0.0286	0.0024	NS
Trt* period* flock	84	0.225	0.0027	NS

** significant at 0.01; *significant at 0.05

The mean values of tail volume for the 4 flocks of the study are summarizad in tables 38, 39, 40 and 41.

Table 38: Tail volume of Awassi ewe during P1 period

	Tail volume±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	1.21±0.04$_a$	1.23±0.05 $_a$	1.21±0.04$_a$	1.18±0.03 $_a$	1.21±0.05 $_a$
Psw+	1.13±0.02 $_a$	1.18±0.06 $_a$	1.25±0.09 $_a$	1.18±0.03 $_a$	1.18±0.06 $_a$
Plw	1.38±0.02 $_b$	1.48±0.02 $_b$	1.53±0.01 $_b$	1.38±0.02 $_b$	1.48±0.02 $_b$
Plw+	1.43±0.05 $_b$	1.53±0.05 $_{bc}$	1.59±0.06 $_{bc}$	1.53±0.05 $_{bc}$	1.53±0.05 $_b$
Msw	1.17±0.02 $_a$	1.27±0.02 $_a$	1.35±0.03 $_a$	1.20±0.05 $_a$	1.27±0.02 $_a$
Msw+	1.36±0.02 $_b$	1.51±0.04 $_{bc}$	1.61±0.05 $_{bc}$	1.48±0.04$_{bc}$	1.45±0.00 $_b$
Mlw	1.46±0.01 $_b$	1.56±0.01 $_{bc}$	1.58±0.01 $_{bc}$	1.52±0.01 $_{bc}$	1.53±0.03 $_b$
Mlw+	1.72±0.01 $_c$	1.77±0.06 $_c$	1.79±0.05$_c$	1.78±0.05 $_c$	1.71±0.05 $_c$
Average	**1.36±0.19$_a$**	**1.44±0.20 $_a$**	**1.49±0.20 $_a$**	**1.41±0.21$_a$**	**1.42±018 $_a$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

Table 39: Tail volume of Awassi ewe during P2 period

	Tail volume±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	1.26±0.03$_a$	1.35±0.01 $_a$	1.35±0.03$_a$	1.25±0.02 $_a$	1.34±0.01 $_a$
Psw+	1.22±0.08 $_a$	1.32±0.08 $_a$	1.38±0.09 $_a$	1.25±0.05 $_a$	1.32±0.08 $_a$
Plw	1.48±0.03 $_b$	1.58±0.03 $_b$	1.53±0.06 $_b$	1.48±0.03 $_b$	1.58±0.03 $_b$
Plw+	1.58±0.01 $_b$	1.65±0.04 $_{bc}$	1.70±0.05 $_{bc}$	1.65±0.04 $_{bc}$	1.65±0.04 $_{bc}$
Msw	1.21±0.02 $_a$	1.31±0.01 $_a$	1.41±0.02 $_a$	1.22±0.03 $_a$	1.30±0.01 $_a$
Msw+	1.48±0.03 $_b$	1.58±0.03 $_b$	1.68±0.03 $_{bc}$	1.56±0.02$_{bc}$	1.48±0.03 $_b$
Mlw	1.50±0.01 $_b$	1.60±0.01 $_{bc}$	1.62±0.03 $_b$	1.59±0.02 $_{bc}$	1.60±0.01 $_{bc}$
Mlw+	1.74±0.01 $_c$	1.86±0.01 $_c$	1.87±0.02$_c$	1.86±0.01 $_c$	1.81±0.01 $_c$
Average	**1.43±0.19$_a$**	**1.53±0.19 $_a$**	**1.57±0.18 $_a$**	**1.48±0.23 $_a$**	**1.51±0.18$_a$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

Table 40: Tail volume of Awassi ewe during P3 period

	Tail volume±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	1.37±0.02 $_a$	1.41±0.01 $_a$	1.45±0.03 $_a$	1.32±0.03 $_a$	1.40±0.02 $_a$
Psw+	1.39±0.06 $_a$	1.49±0.06 $_a$	1.54±0.08 $_a$	1.39±0.06 $_a$	1.48±0.06 $_a$
Plw	1.52±0.02 $_b$	1.62±0.02 $_b$	1.66±0.02 $_b$	1.52±0.02 $_b$	1.62±0.02 $_b$
Plw+	1.67±0.04 $_{bc}$	1.77±0.04 $_{bc}$	1.79±0.05 $_{bc}$	1.77±0.04 $_{bc}$	1.77±0.04 $_{bc}$
Msw	1.22±0.01 $_a$	1.32±0.01 $_a$	1.42±0.01 $_a$	1.28±0.04 $_a$	1.25±0.03 $_a$
Msw+	1.46±0.22 $_b$	1.69±0.03 $_b$	1.80±0.03 $_{bc}$	1.68±0.03 $_b$	1.60±0.03 $_b$
Mlw	1.55±0.03 $_b$	1.65±0.03 $_b$	1.68±0.01 $_b$	1.64±0.02 $_b$	1.65±0.03 $_b$
Mlw+	1.84±0.01 $_c$	1.94±0.01 $_c$	1.94±0.01 $_c$	1.96±0.02 $_c$	1.86±0.01 $_c$
Average	**1.50±0.19 $_a$**	**1.61±0.20 $_a$**	**1.66±018 $_a$**	**1.57±0.24 $_a$**	**1.58±020 $_a$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

Table 41: Tail volume of Awassi ewe during P4 period

	Tail volume ±SE				
Age	Flock1	Flock2	Flock3	Flock4	Flock5
Psw	1.39±0.01 $_a$	1.36±0.11 $_a$	1.38±0.14 $_a$	1.29±0.06 $_a$	1.36±0.11 $_a$
Psw+	1.31±0.06 $_a$	1.48±0.15 $_a$	1.49±0.16 $_a$	1.38±0.15 $_a$	1.45±0.11 $_a$
Plw	1.49±0.05 $_b$	1.59±0.05 $_b$	1.64±0.12 $_b$	1.61±0.08 $_b$	1.59±0.05 $_a$
Plw+	1.74±0.13 $_c$	1.84±0.13 $_c$	1.84±0.13 $_c$	1.84±0.13 $_c$	1.84±0.13 $_c$
Msw	1.25±0.00 $_a$	1.30±0.07 $_a$	1.35±0.14 $_a$	1.29±0.06 $_a$	1.20±0.07 $_a$
Msw+	1.64±0.03 $_b$	1.74±0.03 $_{bc}$	1.79±0.10 $_c$	1.69±0.05 $_b$	1.64±0.03 $_b$
Mlw	1.57±0.03 $_b$	1.67±0.03 $_b$	1.68±0.14 $_b$	1.62±0.05 $_b$	1.56±0.01 $_b$
Mlw+	1.74±0.22 $_c$	1.84±0.22 $_c$	1.84±0.23 $_c$	1.58±0.01 $_b$	1.70±0.21 $_c$
Average	**1.51±0.19 $_a$**	**1.60±0.21 $_a$**	**1.62±0.20 $_a$**	**1.53±0.20 $_a$**	**1.54±0.20 $_a$**

a, b, c: In column for each group of animals and each phase, on line, for the total enters period, the figures with different exhibitors represent a significant difference with $p<0.05$.

According to tables 38, 39 and 40; the mean values of tail volume for primiparous showed no significant difference between improved and tradtionnal system. Large weight females showed higher values of tail volume than small weight females. At period 4 (table 41) improved groups (Psw+ and Plw+) showed higher values of tail volume than traditionnal groups (Psw and Plw). For multiparous, females of the improved system showed higher values of tail volume than traditionnal system throughout the experiment.

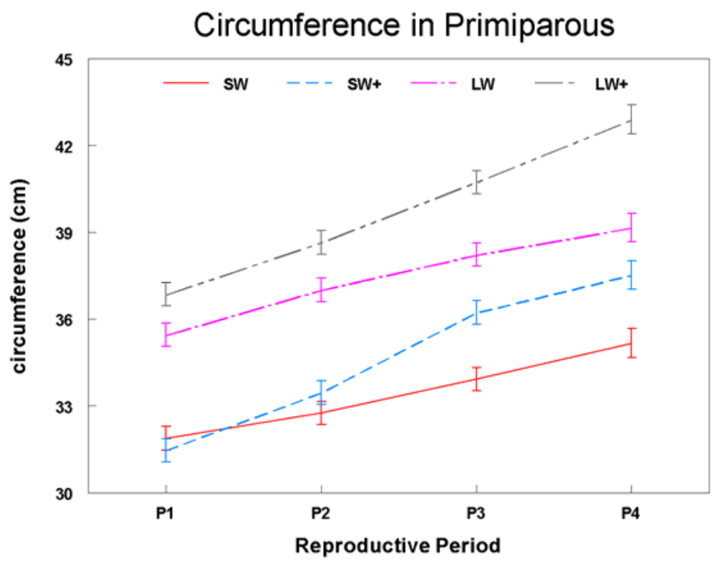

Figure 32. Evolution of tail circumference for primiparous ewes during reproduction period.

Lw= large weight; sw= small weight; += supplementation
P1= first phase of the reproductive period; hot phase
P2= second phase of the reproductive period; mating season
P3= third phase of the reproductive period; dry period
P4= fourth phase of the reproductive period; rainfall season

According to figure 32, all groups of primiparous showed a linear increase in their tail circumference during the 4 period of the experiments. large weight primiparous ewes of the improved system increased their tail circumference significantly faster ($P<0.05$) than large weight females of the traditionnal system. Small weight primiparous ewes of the improved system started with similar ($P>0.1$) tail circumferences as those of traditionnal system then increased ($P<0.05$) their tail circumference above the traditional group starting period 3.

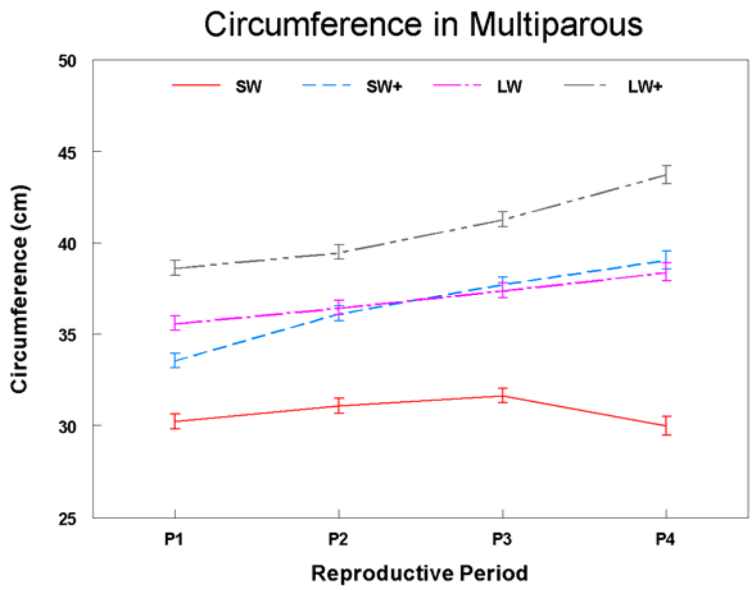

Figure 33. Evolution of tail circumference for multiparous ewes during reproduction period

Lw= large weight; sw= small weight; += supplementation
P1= first phase of the reproductive period; hot phase
P2= second phase of the reproductive period; mating season
P3= third phase of the reproductive period; dry period
P4= fourth phase of the reproductive period; rainfall season

According to figure 33, both large weight and small weight primiparous ewesof the improved system increased their tail circumference significantly greater (P<0.05) than those lw and sw of the traditionnal system. Small weight primiparous ewes started with different (P<0.05) tail circumferences with the improved group matching (P<0.05) their tail circumference to the traditional large weight group starting period 2.

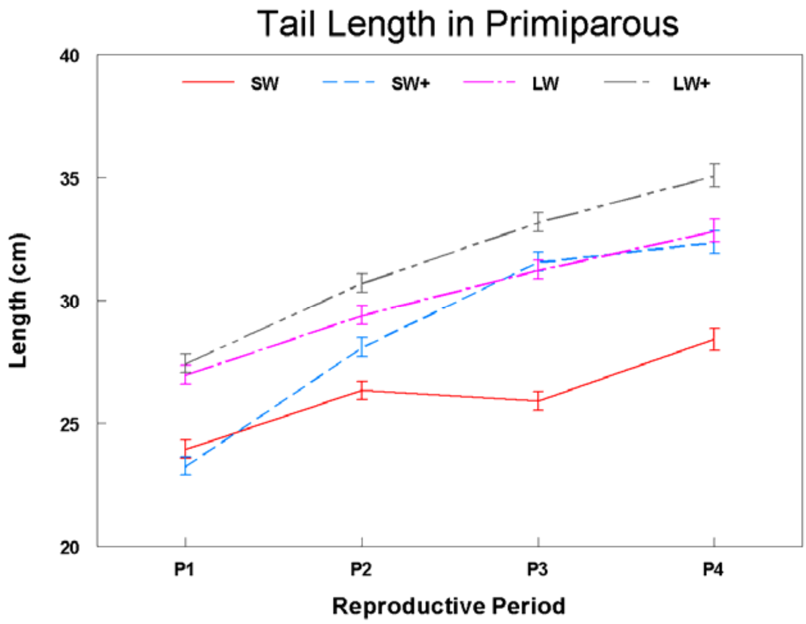

Figure 34. Evolution of tail length for primiparous ewes during reproduction period

Lw= large weight; sw= small weight; += supplementation
P1= first phase of the reproductive period; hot phase
P2= second phase of the reproductive period; mating season
P3= third phase of the reproductive period; dry period
P4= fourth phase of the reproductive period; rainfall season

In primiparous ewes (figure 34), both small and large weight ewes of the improved system started with similar tail length values (P>0.1) as those of traditionnal system increasing (P<0.05) their tail length above the traditional management group starting period 2. In addition, the improved small weight ewes increased (P<0.05) their tail length to match (P>0.1) that of large weight traditional group starting period 3.

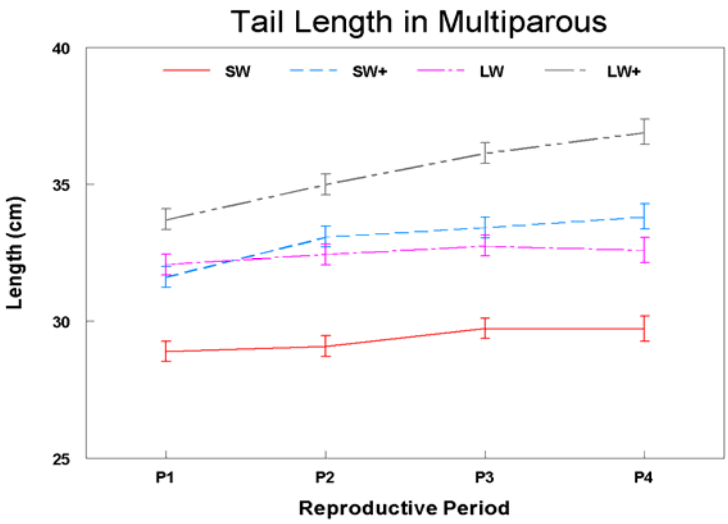

Figure 35. Evolution of tail length for multiparous ewes during reproduction Period.

Lw= large weight; sw= small weight; += supplementation
P1= first phase of the reproductive period; hot phase
P2= second phase of the reproductive period; mating season
P3= third phase of the reproductive period; dry period
P4= fourth phase of the reproductive period; rainfall season

On the other hand (figure 35), in multiparous ewes, the improved group had greater tail length in all periods above the traditional groups. The improved small weight group matched the traditional large weight group in all periods.

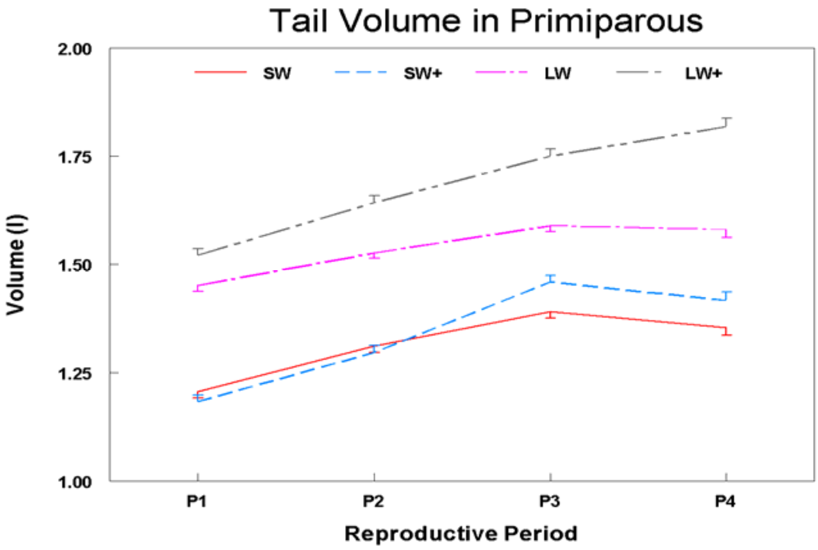

Figure 36. Evolution of tail volume for primiparous ewes during reproduction period

Lw= large weight; sw= small weight; += supplementation
P1= first phase of the reproductive period; hot phase
P2= second phase of the reproductive period; mating season
P3= third phase of the reproductive period; dry period
P4= fourth phase of the reproductive period; rainfall season

In primiparous ewes, small weight ewes of the improved system started with similar ($P>0.1$) tail volume as traditionnal ones. while those of large weight of improved system started with different ($P<0.05$) tail length than traditionnal ones. increasing ($P<0.05$) their tail volume above the traditional management group starting period 3.

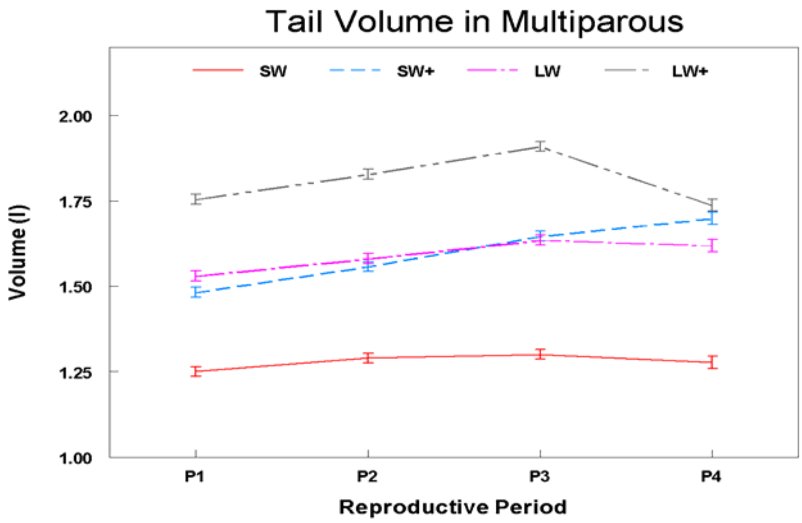

Figure 37. Evolution of tail volume for multiparous ewes during reproduction period

Lw= large weight; sw= small weight; += supplementation
P1= first phase of the reproductive period; hot phase
P2= second phase of the reproductive period; mating season
P3= third phase of the reproductive period; dry period
P4= fourth phase of the reproductive period; rainfall season

Both small and large weight ewes multiparous of the improved system started with different ($P<0.05$) tail volume than traditionnal groups. In period 4 large weight ewes showed a decline in tail volume unexpectadly. These ewes had probably lost some of the fat reserves from the tail due to more requirements for energy associated with their larger body weight. In addition, the improved small weight ewes increased ($P<0.05$) their tail length to match ($P>0.1$) that of large weight traditional group starting period 3.

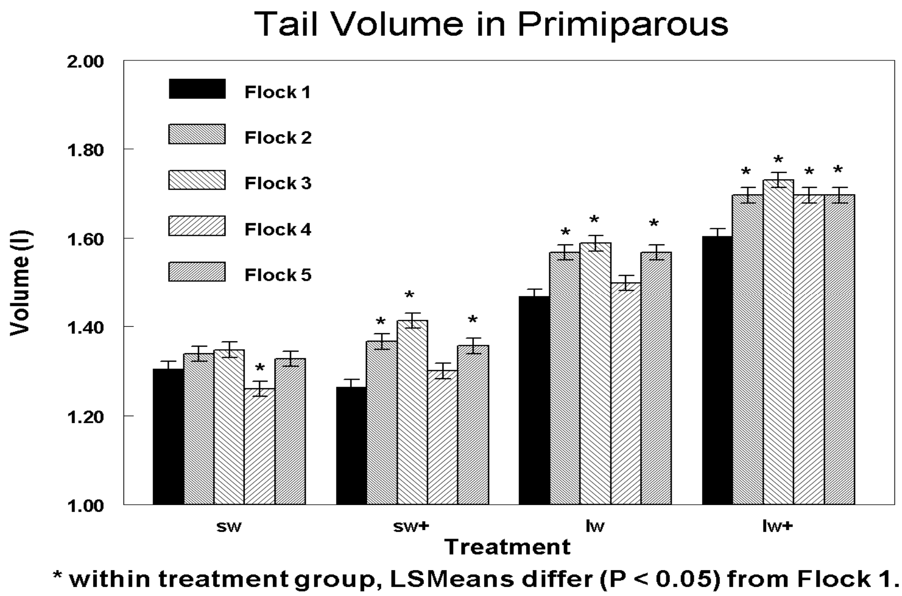

Figure 38. Evolution of tail volume for primiparous according to different regions.

In primiparous ewes, differences in flocks might have affected some of the observed results in tail volume as associated with the treatment.

When supplemented primiparous ewes tend to deposit excess energy in their tails in forms of fat. In fact, flocks 2, 3 and 5 showed an increase above flock 1 and 4 and above their non supplemented counterparts, in their fat tail volume with supplementation. In both Baabda (an urbanized area) and Hermel (a semi – arid area) the fat tail volume was significantly lower in all treatment except the supplemented large weight ewes. The low quality pasture in these 2 regions forces the ewes to mobilise the fat deposit in the tail as observed by lower tail volume.

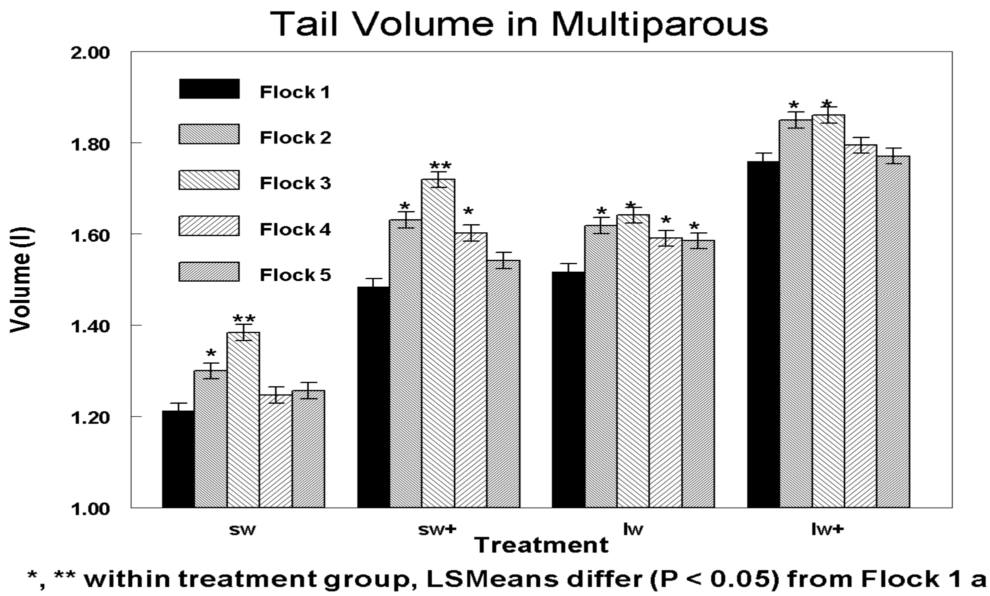

Figure 39. Evolution of tail volume for multiparous according to different regions.

Small weight Multiparous started with tail volume lower than primiparous due the energy required by previous pregnancy. When supplemented or when they were larger in weight, the fat tail reserves were higher and they accumulate more fat in their tail.

4.2.3 Effect of body condition on the reproductive performance of ewe

Fertility and prolificacy for each flock were recorded during the experiment, simultaneously BCS were measured monthly during this period.

Table 42: Fertility, prolificacy and body condition score (mean ±SD)for each flock

Flock	BCS at mating	BCS at parturition	fertility (%)	Prolificacy (%)
Psw	2.63	2.53	49	55
Psw^+	2.81	2.97	76	65
Plw	2.97	2.65	61	71
Plw^+	3.72	3.89	87	87
Msw	2.87	2.65	70	89
Msw^+	3.14	3.27	79	94
Mlw	3.02	2.99	80	93
Mlw^+	3.23	3.47	89	97
Flock 3	3.17	3.7	87	95
Flock 2	3.14	3.3	83	93
Flock 5	3.17	3.1	73	83
Flock 4	3.05	2.7	60	65
Flock 1	2.46	2	56	60

Table 42 shows that the body condition score of ewes in Lebanon varies from one geographical region to another. Flocks Bekaa and Akkar valley (flock 3 and flock 2) were shown to have the higher body condition score and consequently the high fertility and prolificacy performances. Table 42 shows also that the 2 flocks of bekaa and Akkar valleys are able to increase their fat depots between mating and parturition while the remaining flocks specially those of Mount Lebanon and South Lebanon showed noticeable depletion in their fat depots at parturtition.

4.2.4 Effect of body condition of ewes on birth weight of lambs and their survival rate

Average body weight of lambs, recorded at birth, was higher in multiparous ewes and in these of the improved group.

Table 43: Body weights at birth (mean± SD) and survival rate of lambs for different female groups

Groups	Weight at birth	Survival rate at 2 months post parturition
Psw	3.7±0.5 ^{a}	75%
Psw^{+}	4.3±0.55 ^{b}	80%
Plw	3.6±0.72 ^{a}	81%
Plw^{+}	4.5±0.66 ^{b}	90%
Msw	3.9±0.45 ^{a}	79%
Msw^{+}	4.3±0.39 ^{b}	87%
Mlw	4±0.50 $^{a\,b}$	95%
Mlw^{+}	4.5±0.37 ^{b}	100%

The body weight at birth of lambs was higher in multiparous compared to primiparous ewes although the latter had a higher prolificacy rate. The rate of lamb survivals was also higher in multiparous compared to primiparous ewes.The two lambs traits were also higher in heavy weight ewes compared to the light ones and in the improved system compared to the traditionnal one. Higher lamb survival obviously can be associated with higher body weight at birth and, maybe, by higher milk production of well-nourished ewes.

Correlation coefficients were calculated between birth weight of lambs and their survival rate and all parameters of body and tail measurements at the end of the P4 phase, as shown in table 44.

According to this table , strong correlation coefficients ($p<0.01$) were established between all parameters of body and tail growth of female and the lamb weights at birth and their survival rate. A higher survival rate of lambs was associated with higher body weight at birth and the higher milk production of their mother.

Table 44: Phenotypic relationship (correlation coefficients) between body and tail measurements and survival rate of lambs at the end of P4 phase.

	Parameters	Lamb birth weight	Survival rate
Body measurements	Age	0.80 **	0.80 **
	Body weight (kg)	0.85 **	0.90 **
	Body circumference	0..75**	0.75**
	Body length	0.60**	0.70**
	BCS	0.98**	0.97**
Tail Measurements	Tail length	0.95**	0.90**
	Tail circumference	0.87**	0.79**
	Tail volume	0.85**	0.90**

** $p<0.01$

This study however needs to be complemented by an advanced rentability study on the economics of an advanced raising system, taking into account the cost of feed supplements and achieved increase in the production of ewes.

Only by economics recommendations for addition of supplement into the raising system can be made that could be appropriate for the extensive lebanese raising system.

4.3 Discussion

4.3.1 Body weight

In the first experiment, small weight and large weight ewes (hoggets, primiparous and multiparous) of the traditional system showed continuous body growth only during the P1 phase whereas during phases P2, P3 and P4 they underwent a decline in growth compared to the ewes of the improved system. Results of Abi Saab *et al.* (1984, 1999) showed that marked body growth occurs in the plain of Bekaa during July-August due to the quality of the seasonal pastures. From September, the ewes of the traditional breeding system showed a body growth lower than those of the improved breeding system, this can be due to the fact that these ewes graze all year in a restricted overground area; also, this pasture is mountainous, consisting of slopes and terraces. Under these conditions the animals loose more energy in search of feed than they gain by feed found, which is in agreement with Abi Saab *et al.* (1999). It follows that the introduction of barley supplement by the stockbreeders during November is able to maintain body weights almost constant during this period and thus to preserve the fat deposits for later phases, like parturition and lactation; this approach was also suggested by Treacher *et al.* (1992) who recommended that the introduction of a supplement during autumn and winter helps the ewes to require a good body condition before parturition in this season, while pastures constitute the base of the rations during spring and summer. The grazed species during these seasons presented protein content that is higher than in the majority of concentrates offered. Also, Banskalieva *et al.* (1998), Petrova *et al.* (1994) and Webb *et al.* (1994) observed that the introduction of measured amounts of concentrates into the ration in the traditional system is beneficial for a better body development. According to Landeau and Molle (1987) a high nutrition level affects the growth of an animal and consequently reduces the age at reaching mature body weights.

According to the second experiment, the trends of weight evolution is also function of the geographical regions where flocks had been raised. The lowest values of body weight were recorded for flocks raised of Mount Lebanon and Lebanon, and the highest values were recorded for flocks raised at Bekaa and Akkar valley. These results are in agreements with those obtained by Abi Saab *et al.* (1999) who noticed that the evolution of body weight of Awassi sheep subjected to an extensive breeding depends on morphological and geographical characteristics on each area (plains or terraces) and the availability and feed value of the pastures. At Mount-Lebanon, the pastures are presebted in the form of laminated spaces and are degraded in their great part. Consequently, the sheep will be led to consume much energy in research of nutrients. While, in Bekaa, the plains are extremely available, the sheep do not have to consume any more much energy at the time of a grazing ground where fodder have not only significant qualities and quantities but also a high nutritive diversity. However, in all the geographical regions, all groups of females both improved and traditionnal showed a steady increase in their body weight throughout the 4 periods of the experiments. However the rate of increase is higher for improved groups than traditiannal ones. In conclusion, the adoption of supplementation is essential to maintain better body development and consequently achieve best reproductive performances. The effectiveness of this system rests on a good feeding stock management in order to avoid the abuse of supplements.

4.3.2 Tail measurements

According to the first expeiment, tail length is a function of age, weight and management system; it evolves parallel with the body condition score. Thus, during the P1 phase, good pastures and low ambient temperatures stimulated the accumulation of tail fat. Poor pastures from August till November associated with overgrazing and high temperatures, then required the contribution of supplements with an aim of reducing the mobilization of the fat reserves; such management is in agreement with Abi Saab *et al.* (1999) who showed that only good pastures in the Bekaa area are secure to achieve required body condition during spring and summer. In contrast, during winter, supplements are essential to make up for the feed deficit in the traditional systems during this period. Bicer *et al.* (1992) observed that the fat deposited in the tail is a source of energy for the periods of low consumption of energy. Hamadeh *et al.* (1996) noted that the contribution of supplements from October and September had to constitute the basis of rations consumed by sheep in the area of Bekaa. Similar results were also obtained by Goodwin (1971) who noted that the fatty tissue is the last to be formed and the first affected at times of feed restriction. Nelson (1964) found that in periods of feed abundance subcutaneous and cavity fat accumulated and decrease without supplementation (Alkass *et al.* (1985); Abi Saab *et al.* (1999)).

In addition, longer tails in multiparous than in primiparous ewes and in hoggets were recorded by Owen (1976) who showed that under reduced growth conditions animals are already born with a shorter tail, and as body weight increases, the quantity of fat tail increases. Similar results are also reported by Zamiri and Izadifard (1997) who showed that 2 to 3 years old ewes have a significant fattier tail and consequently more fat deposits than 1 to 2 year old ewes.

According to the second experiment, tail length is function of body weight, the geographical regions and the breeding system (extensive or improved). Large weight females both primiparous and multiparous showed higher values of tail length than small weight animals. These results are in agreements with the results obtained by Owen (1976) who noticed that as the weight of lamb sheep increase the quantity of fat increase, and those obtained by Berg and Walters (1983) who added that the fat deposition is believed to start out relatively slowly and increased geometrically as the animal enters a fattening phase. Females of improved system both small and large weight ones showed higher values of tail length than those of traditionnal system. Results also obtained by Gatenby (1986) who reported that fat is deposited only if surplus of nutrients are available and by Abi Saab et al. (1999) who showed that nutrition is one of the factors that infkuence more the deposit of fat, since with nutrition rich in concentrates and energy a share of this energy would be used by tissues and body cells to improve growth and development, the part which remain will be used for the deposit of fat. The fatty tail of the Awassi sheep depends on geographical and morphological characteristics of the area where flocks were raised; with the longest fatty tail being noticed for flocks raised at Bekaa and Akkar valleys and the shortest ones for the flocks raised at Mount And South Lebanon. Results also reported by Abi Saab et al. (1999) who reported that the raised sheep at Bekaa have a fatty tail larger than those in Mount-Lebanon. At mount Lebanon, plains are totally absent while foothill steppes and slopes are predominant. This condition forces the animals to consume more energy in the search of nutrients which seems to be depleted due to the urbanization of the area.While at Bekaa, the grazing grounds are usually plains rich in fodder with high nutritive quality.

According to the first experiment, tail circumferences were also affected by weight, age and management system. The results obtained for hoggets showed that the contribution of barley supplement for low weight hoggets not only lead to the improvement of their body weight and their body condition score but also to a better tail growth, thus involving an early release of maturity as show by Landeau and Molle (1987). The effect of the supplement on the tail circumference of large weight hoggets though was less intense. However, Goodwin (1971) learned for the effects of overfeeding, that a very large fat tail, following a feed rich in concentrates, can have harmful effects on mating and fertility.

For primiparous and multiparous ewes it appears that a feed supplement is essential especially during the period from September-October in order to compensate for feed starvation and the bad physiological state of the animal. This is in agreement with recommendations by Bankaslieva *et al.* (1988), Petrova *et al.* (1994) and Webb *et al.* (1994).

According to the second experiment, tail circumference is also function of body weight, the geographical regions and the breeding system. Females of the improved system showed higher values of tail circumference than those of traditionnal systems. Results also observed by Godwin (1971) who mentioned that the greatest loss at the time of feed restriction is that of the stored fat. Whereas if concentrates exist, they lead to the formation and deposit of fat. Fatty tail circumference is also function of the geographical regions where flocks had been raised with the largest circumference for the flocks raised at Bekaa and the thinnest tail circumference for those raised at Mount Lebanon. Thes results are in agreements with those obtained by Black (1990) who reported that feed intake and consequently fat deposit were closely correlated with both the amount of pasture available per animal per day and the digestibility of the forage selected. At Mount Lebanon, the vegetation is scarce mainly shrubs of low digestibility. While those of Bekaa are usually herbaceous with high protein content.

In conclusion, the contribution of a supplement is essential during the months September-November, with an aim of ensuring a sufficiently developed deposit of subcutaneous and tail fat. This makes it possible for females to bridge time until the later phases like parturition and lactation. These are the phases during which the mobilization of food deposits is inevitable to secure reproductive performance (Atti, 1991).

According to the first experiment, during the second phase of the reproductive period, the evolution of tail volumes was more marked in females of the improved management system than in those of the traditional one. Abi Saab *et al.* (1999) showed that during the months June-August, the richness of the pasture in the area of Bekaa is able to stimulate good body growth and body condition in the ewes. However, the reduction of tail volumes at the end of the sexual season in the females of the traditional system is attributed to the fact that grazing becomes poor and insufficient supply required energy. The mobilization of the fat deposits operate as a physiological response to feed starvation (Economides,1995). This reduction of the tail volumes at hoggets through September to October can be due to the fact that the hoggets during this period introduced into the adult herd and are thus obliged to cross a long distance and entered in competition with the adult females in search of feed sources, these factors could be an additional reason for reduction of tail volume.

The same results were obtained in the second experiments with higher values of tail volumes being recorded for large weight animals of the improved system. Largest tail volumes were also reported for flocks raised at Bekaa and Akkar valleys.

4.3.3 Body condition scores (BCSs)

The body condition score varied with the age of the animal, the weight and management and the geographical regions where flocks had been raised. The body condition score is a subjective method to assess the accumulation and mobilization of fat reserves in times of sufficient and scarce feed. Kabbali *et al.* (1992) showed that the rate of mobilization of fat reserves is function of the severity and the duration of feed shortage, of the maturity of the animal and of its physiological state.

As for age, the hoggets in this study showed linear growth with age, with a higher gain in the improved system, This agrees with Owen (1976), who showed that at birth, an animal contains little fat, however, the muscular components increase more quickly than the essential parts, whereas the deposits of fat are the last to evolve and are the most severely affected by feeding conditions. This explain why females of the improved system (in the 2 experiments) did have a higher deposit of subcutaneous fat than those of the traditional system.

In the 2 experiments, the primiparous and the multiparous ewes of the traditional system showed a notable reduction of body condition scores during the P3 and P4 phases. This agrees with the results of Burton *et al.* (1972) who showed that the rate of mobilization of the fat deposits is more intense in adult animals than in hoggets. The notable reduction of the body condition score noted during the P4 phase for different groups of primiparous and multiparous ewes was also reported by Atti (1991) who showed that with certain phases of the reproductive cycle (pregnancy), the mobilization of fat deposits is inevitable in order to compensate the feed deficits caused by the physiological state of the female.

In the 2 experiments, better body condition scores were higher for females of improved system; this agrees with Goodwin (1971) who observed that the greatest loss of weight at times of food restriction are due to fat stored and with Miller *et al.* (1986) who documented how with different levels of supplement fat tissue develops faster. Treacher *et al.* (1992) recommended that supplementation during October-November is necessary in order to reduce the mobilization of fat deposits caused by both the food depletion and by the physiological state of the animal. In fact, during this period, the ewes which mated in August are in their middle pregnancy period , their energy demand is generally higher than the energy required from pasture. The quantity of supplements to be offered thaugh a function of the quality of pastures.

Thus, supplements during the two phases P1 and P2 of the reproducitve period do not seem to have beneficial effects on the accumulation of fat in the females of the improved system owing to the fact that the pastures in the Bekaa are generally rich during July-August (Abi Saab *et al.* , 1998). This situation is reflected in the body growth and consequently in the deposit of subcutaneous fat, involving an increase in the body condition scores in all the females during this phase; in contrast, during September, the contribution of supplements is essential to prevent the mobilization of the fat deposits and consequently to alleviate the reduction of body condition scores(Atti ,1991).

Therfore, in order to maintain a better body condition, the use of supplements during September and November is essential, because of the impoverishment of pasture as well as due to an increase in the energy needs of the pregnant females .

4.3.3.1 Body condition scores in different geographical regions of lebanon

Flocks of central Bekaa and North of Lebanon (flock 3 and flock 2) were shown to have the higher body condition score and consequently the high fertility and prolificacy performances. These 2 geographical regions provide a very rich pasture of cereals and legumes by products that enhances the accumulation of fat reserves in different body organs of the ewes providing them with high body condition score and consequently high fertility and prolificacy, flock's supplementation with concentrates in summer months could be a waste of money. The lowest BCS were recorded in the coastal region of Mount Lebanon (flock 1) attributed to the scarcity of food in these regions due to the scarcity of pasture. In all lebanese regions, Lebanese sheep production systems are, for the most part extensive. They are based on natural mediterranean ranges grazing supplemented in winter by cereal stubble, fallow, and more frequently graines. Such system are characterized by seasonnal shortage and annual scarcity of food resources. If high mortality caused by starvation is now, quite unusual, flock productivity remains limited in almost all regions of Lebanon. Ewes face at least partially food shortage by body reserves utilisation. Range supplemenation by conserved roughages and concentrates allows to remedy to such situations, but for different reasons (food availability and cost, as well as low productivity of flocks), the level and duration of supplementation must be limited. It is therefore essential to have early, simple and reliable indicators at hand, which allow to assess animal nutrition level and to decide when and how to supplement the whole flock or part of it if possible. The Body condition score appears to be the most easy and reliable indicators. Therefore it could be beneficial to establish a threshold of BCS for each phase of production cycle of the ewes. These values should include mean values and tolerable variation limits. In our study, higher fertility and prolificacy of ewes are obtained from sheep with BCS from 3-4 at mating. These results were similar to those obtained by Molina et al. (1994).

4.3.4 Correlations between the body condition score and the various parameters of body and tail growth for the various groups of females during the reproductive period.

The body measurements of the various age groups of hoggets and primiparous and multiparous ewes showed significant correlations ($p<0.01$) with the body condition scores. These correlations between body weight and BCS varied from 0.79 for Hlw to 0.98 for Hsw+; in primiparous ewes this correlation varied between 0.76 for Psw to 0.98 for Plw+. This result can be attributed to the fact that with improved feeding ewes of different age are able to store more subcutaneous fat. (Miller *et al.* (1986), Banskalieva *et al.* (1988) and Webb *et al.* (1994)).

In addition, the BCSs showed highly significant correlations ($p<0.01$) with the various parameters of tail growth. These correlations were stronger for the females of the improved system. Thus, as an example, for multiparous ewes , the correlations between body condition scores and tail volumes were $r=0.95$ ($p<0.01$) for the two groups Msw+ and Mlw+ (improved supplementation) and $r=0.83$ ($p<0.01$) and 0.49 ($p<0.05$) for the two groups Msw and Mlw into traditional system. Similar results were obtained by Abi Saab *et al.* (1999).

4.3.5 Oestrus occurence

The detection of heats in primiparous and multiparous ewes showed that the majority of the females of the various age and weight groups did come into heat in the presence of the males although at different speed (Fig.27); The high weight multiparous ewes were the first to express signs of heat, and thus did attain a higher oestrus rate than primiparus ewes at the peak of heats, recorded at the fourth week (93, 90, 87 and 80% for Mlw, Msw, Plw and Psw respectively). This is in agreement with Baril *et al.* (1993) who showed that the separation of the two sexes in as ovine herd, followed by an abrupt introduction of the males, is a natural method for synchronization of heats. Abi Saab *et al.* (2000), also showed an earlier release of heat in high-weight females than in low-weight females.

4.3.6 Reproductive performance of the four groups of ewes in comparison to body condition score

In the first experiment, no cases of pregnancy or parturition were detected in hoggets in spite of their introduction into the adult herd during September. This can be due to the fact that the hoggets did not show oestrus. It is possible that contribution of an earlier supplementation can improve body growth and consequently start an early sexual maturity in hoggets, as suggested by Landeau and Molle (1987). In addition, multiparous ewes show high pregnancy and parturition rate than primiparous animals.

As for primiparous and multiparous ewes, the rates of conception and parturition were higher in the high weight than in low weight groups, which is in agreement with Thomson and Bahhady (1988) who reported a fertility rate of 100% in females weighing more than 50 kg. These results are also in agreement with Smith (1985) and Kassem *et al.* (1989) who reported an increase in fertility following the increase in body weight.

The parturition rate was increased higher in supplemented ewes. Supplementation at the beginning of the mating season causes an increase in the fertility as direct effect of flushing (contribution of an excess of proteins and energy) and an associated increase in body weight, like shown by Landeau and Molle (1987). Similar results are reported by Economides (1995) who mentioned that the reproductive capacities of sheep can be improved by providing the females with a good balanced feed ration before and during the season of mating and in the last weeks of pregnancy. Molina *et al.* (1994) established a strong correlation between the body condition score and fertility; best fertility rates were observed for females with body condition scores from 2 to 4. Reduced fertility is observed for body condition scores exceeding these values; therefore an excessive deposit of fat and consequently an excessive development of fatty tail did reduce fertility. This problem was not observed in this study, therefore the practice of supplementation appears to be adequate for the improvement of body condition and fat reserves under lebanese condition skills.

Parallel to fertility, prolificacy was found to be higher in multiparous than in primiparous ewes, in heavy weight sheep rather than in light weight ones and ewes in the improved system compared to the traditionnal system. The effect of the improvement of body weight and body condition at ewes on prolificacy, as also shown by Brink (1990), is indicated.

Finally, the accumulation and the mobilization of the fat deposits in the females, indicated by the variations of body condition scores and tail measurements (length, circumference and caudal volume), were a function of age, body weight, management, season and the physiological state of the females.

In hoggets, the accumulation of fat increased with age and high weight hoggets did maintain their subcutaneous fat deposits (body condition score) and tail superiors better than small weight hoggets. Supplementation did improve body condition scores and tail measurements for hoggets but did not induce the occurence of oestrus (Hsw^{+} and Hlw^{+}) in this animal group.

For primiparous and multiparous ewes, body condition scores and fat accumulation in the tail were higher in high weight females than in low weight ewes. Supplementation (based on a surplus of concentrates) did improve body condition scores and fat deposits especially during September-November; this made it possible for the animal as soon as to preserve these deposits for the more critical later phases in the production cycle. Body condition scores and tail measurements declined as shown by ewes of the traditional system duiring the P3 and P4 phases. Pregnancy and parturition rates also decreased.

In the second experiment, improved system females showed higher fertility and prolificacy rate than traditionnal group females. These higher fertility and proloficacy rates are associated with better body condition score at mating. These results are also obtained by Afonson and Thompson (1996) who reported the better the condition score at mating, the higher the ovulation rate and therefore the higher the potential lambing percentage, and with the results obtained by Economides (1995) who mentioned that the reproductive capacities of the Awassi ewes could be improved by providing the females with a balanced feed ration before and during the mating season and at the last weeks of pregnancy. Females of large weight showed higher fertility and profilicacy rates than those of small weight animals. This complies with the results obtained by Kassem et al. (1989) who found an increase in lambing percentage of 0.3 to 1.3 for each kg increase in body weight before mating and with those obtained by Thompson and Bahhady (1988) who established a strong correlation between fertility of the Awassi sheep and body weight at time of mating. Females in Bekaa and Akkar valleys showed higher fertility and prolificacy than those raised at Mount-Lebanon. This could be due to the higher body condition scores recorded for these flocks at mating, results also obtained by Molina et al. (1994). However supplement introduction could be beneficial in all the geographical regions of Lebanon, supplementation reduced the mobilization of fat reserves during parturition and suckling. The increased requirements of energy and nutrients, induced by the physiological stage of the female and the scarcity of vegetation, could be alleviated by adequate provision of feed supplements. A decrease in BCS of females could indicate respective harmful effects on the reproductive and productive performances during ulterior phase of the reproduction period.

4.3.7 Effect of body condition of ewes on birth weight of lambs and their survival rate

The body weight at birth of lambs was higher in multiparous compared to primiparous ewes although the latter had a higher prolificacy rate. The rate of lamb survivals was also higher in multiparous compared to primiparous ewes.The two lambs traits were also higher in large weight ewes compared to the small ones and in the improved system compared to the traditionnal one. Higher lamb survival obviously can be associated with higher body weight at birth and, maybe, by higher milk production of well-nourished ewes. These results are similar to those obtained by who reported that ewes with a body condition of 3-4 at lambing lost fewer offspring and weaned heavier lambs than those with condition scorenof 2.5 or less.

Strong correlation coefficients ($p<0.01$) were established between all parameters of body and tail growth of female and the lamb weights at birth and their survival rate. A higher survival rate of lambs was associated with higher body weight at birth and the higher milk production of their mother.

5 CONCLUSION

The present observations outline the effects of a natural climatic environments and its contrated variations, on ewe body condition at mating and on their subsequent producttivity. These results planned to clarify relations between body weight (static effect) and nutrtion during pre-mating weeks (dynamic effect) on the one hand, and fertlity and prolificacy on the other hand.

The body condition score, the growth and body development of the ewes, as well as the evolution of the fatty tail were influenced by the age, the period of reproduction and the management system. In hoggets, the average values of the body condition score showed a linear evolution with the age of the animal to reach a maximum during the dry season, they were higher in the large weight hoggets than in small weight hoggets, and in supplemented versus traditional system. For multiparous and primiparous ewes (both first and second experiment), the body condition score varied during the season of reproduction according to the nature of pasture. The impoverishment of the sites of pasture running the late phases of the reproduction cycle involved a reduction of the more perceptible body condition score in the females in traditional breeding than in those of the improved management. The very rich zone of pasture during the first and second phases was sufficient to maintain a good body and tail development. The last two phases of the reproduction period were accompanied by a reduction of the body and tail condition, this reduction is allotted to insufficient pasture avaibility. This reduction of tail measurements was more intense in the females in the traditional system than in the improved system. According to the second experiment, the amount of fat mobilization is also function of the morphological and geographical regions where flock has been raised. The higher body condition scores and fatty tail measurements were being recorded for flocks raised at Bekaa and Akkar valley and the lowest measurements for those raised at Mount Lebanon. At Mount Lebanon, the grazing grounds are mainly mountainous with steppes and hills; forcing the females to consume more energy in the search of nutrients that seems to be scarce due to the urbanization of the area; At Bekaa, the grazing ground are mainly valley rich in green fodder of high nutritive values.

The reproductive capacities of the females estimated by synchronization of heat, the rate of pregnancy and parturition were a function of the age of the animal, its body state, the geographical region and the adopted management system. Thus, the large weight multiparous ewes showed the highest rate of heat (for the 2 experiments). The rate of pregnant females and rate of parturition was higher for the multiparous than for primiparous, and for those of large weight than for small weight, for ewes in the improved system than in the traditional breeding (in the 2 experiments). In the second experiment, females raised in Bekaa and Akkar valleys showed the highest fertility and prolificacy rates than the other geographical regions. These higher rates are associated with higher body condition score at mating in these plains.

However it is also possible to take advantage of the ability of ewes to keep their reproductive performance at a fairly good and steady level even when food scarcity induces marked body weight losses. It is then possible to reason over ewe distribution and to suggest, as before mating management targets, not a body weight or body condition score mean value for the flock, but a maximum frequency of ewes with poor or even bad body conditions. For that, we must take into account the main constraints of such systems, breed characteristics and production purposes. In most situations, as a consequence of the low prolificacy, high fertility and early conception date can be considered as the key of a successful mating period.

Supplemenation of such animals is very important during the dry season but it is difficult to justify an economic basis.

6. Summary

The relationship between reproductive performances and body condition score has been studied in 2 different surveys in Awassi sheep in Lebanon.

In the first survey, 72 experimental animals were grouped according to age (ewe lamb A, primiparous P, multiparous M), to body weight into small weight (SW) and large weight (LW), and kept under two management systems: traditional and improved (barley supplement). The reproduction period has been divided into four phases: early phase or hot season (P1: mid July – mid August), mid phase or mating season (P2: mid August – mid September), third phase or dry season (P3: mid September – mid October) and late phase or rainfall season (P4: mid October – mid November). Body fat accumulation has been estimated by using the body condition score (BCS= 0 -5) and tail measurements. For ewe lambs, the mean values of BCS were significantly higher ($p<0.05$) in LW than SW groups during P1 and P2 (2.94 ±0.24 vs 2.28 ± 0.57 et 3.25± 0.44 vs 2.63± 0.49). During P3 and P4, these values were higher ($p <0.05$) for the ewe lamb in the improved system than those in traditional system (3.39±0.50 vs 2.94± 0.24 et 3.33± 0.52 vs 3.17± 0.41). Primiparous and multiparous ewes showed a higher BCS ($p<0.05$) in the improved system than those in the traditional system. The BCS measures were highly significant ($p<0.01$) correlated with tail measures and body weights. The percentage of females detected in heat during the fourth week post introduction of males was higher for the (MLW) than for other groups MSW, PLW, PSW (93 % vs 89 %, 87 % and 80%) respectively. The percentage of pregnancy and parturition were higher for large weight than small weight ewes and in the improved than the traditional system. From September till October, the poor pasture offered in traditional system induced stabilization in BCS, body and tail growth; accompanied by a reduction in the reproductive performance of females. The adoption of advanced raising system could be a solution.

In the second survey, flocks from 5 geographical regions (Mount-Lebanon, Central Bekaa, Hermel, South-Lebanon, North-Lebanon) were selected. Parallel to the first experiement, females were gathered into different groups according to their age (primiparous and multiparous), their body weight (small and big) and the breeding system adopted (traditionnal and improved). body condition score, tail measurements were assessed in a weekly basis, fertility and prolificacy of these flocks

were also assessed, parallel with the rate of offspring survival. Flocks in central Bekaa and North-lebanon have shown higher BCS and tail measurements throughout the experiment and consequently higher fertility. The lowest values for all these parameters were recorded in Mount Lebanon. The difference between flocks in all parameters is due to the difference in the quality of pasture between the different geographical regions, and it could be also attributed to the difference in the morphological characteristics of the sites of grazing. However, for the 5 geographical regions, it looks obvious that the introduction of supplements seems to have beneficial effect on the evolution of body condition score and consequently the reproductive parameters of the ewes.

As conclusion, the BCS provides a reliable assessment of fat reserves in ewes, and is a valuable criterion in modelling the relationships between feeding and animal performances. Simple, reliable, The BCS could be used by farmers.

In other hand, as the first survey shows that from September to October, the poor pasture offered in traditional system , insufficient for attaining optimal body condition and reproductive performances, require adoption of supplementation in that period. The second survey shows that the time and the quantity of supplementation to be offered should be function of season, geographical region and the quality of pasture offered. For these reasons, a threshold of BCS should be established for each productive period of ewes. At mating the BCS should range between 3 and 4.

Keywords: Sheep, breed, characterization, body weight , body measurements adipose tissue, body condition score, fat deposition parturition rate, pregnancy rate.

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8. APPENDICES

Appendix 8.1. ANOVA table with 3 factors for body weight during all phases of the reproduction period according to the three factors age, body weight, supplementation or breeding system.

Appendix 8.1.1. Body weight during P1.

Source of variation	df	SS	Ms	
Age	2	6131.230	3065.615	**
Weight	1	485.629	485.629	**
System	1	0.100501	0.100501	ns
Age*weight	2	36.2697	18.1349	**
Age*system	2	8.59534	4.29767	ns
Weight*system	1	0.443368	0.443368	ns
Age*weight*system	2	3.54888	1.77444	ns
Error	60	154.270	2.57117	

* Significant at 0.05
** Significant at 0.01
NS = non significant

Appendix 8.1.2. Body weight during P2.

Source of variation	df	SS	Ms	
Age	2	6199.03	3099.546	**
Weight	1	374.011	374.011	**
System	1	6.19520	6.19520	ns
Age*weight	2	81.0803	40.5402	**
Age*system	2	8.01686	4.00843	ns
Weight*system	1	0.293889	0.293889	ns
Age*weight*system	2	2.31102	1.15551	ns
Error	60	179.770	2.99617	

* Significant at 0.05
** Significant at 0.01
NS = non significant

Appendix 8.1.3. Body weight during P3.

Source of variation	df	SS	Ms	
Age	2	6440.779	3220.389	**
Weight	1	323.088	323.088	**
System	1	34.0038	34.0038	**
Age*weight	2	105.416	52.7080	**
Age*system	2	8.34028	4.17014	ns
Weight*system	1	1.25876	1.25876	ns
Age*weight*system	2	0.214178	0.107089	ns
Error	60	253.896	4.23160	

* Significant at 0.05
** Significant at 0.01
NS = non significant

Appendix 8.1.4. Body weight during P4.

Source of variation	df	SS	Ms	
Age	2	7156.361	3578.181	**
Weight	1	274.170	274.170	**
System	1	49.1701	49.1701	**
Age*weight	2	87.0278	43.5139	**
Age*system	2	15.5278	7.76389	ns
Weight*system	1	9.03125	9.03125	ns
Age*weight*system	2	11.5833	5.79167	ns
Error	60	555.125	9.25208	

* Significant at 0.05
** Significant at 0.01
NS = non significant

Appendix 8.2. ANOVA table with 3 factors for body lenght during all phases of the reproduction period according to the three factors age, body weight, supplementation or breeding system.

Appendix 8.2.1. Body lenght during P1.

Source of variation	**df**	**SS**	**Ms**	
Age	2	1305.600	652.800	**
Weight	1	149.242	149.242	**
System	1	120.0345	120.0345	**
Age*weight	2	1.81434	0.907172	ns
Age*system	2	20.5746	10.2873	ns
Weight*system	1	14.5440	14.5440	ns
Age*weight*system	2	14.2088	7.10441	ns
Error	60	2010.660	33.5110	

* Significant at 0.05

** Significant at 0.01

NS = non significant

Appendix 8.2.2. Body lenght during P2.

Source of variation	**df**	**SS**	**Ms**	
Age	2	1305.600	652.800	**
Weight	1	149.242	149.242	**
system	1	120.0345	120.0345	**
Age*weight	2	1.81434	0.907172	ns
Age*system	2	20.5746	10.2873	ns
Weight*system	1	14.5440	14.5440	ns
Age*weight*system	2	14.2088	7.10441	ns
Error	60	2010.660	33.5110	

* Significant at 0.05

** Significant at 0.01

NS = non significant

Appendix 8.2.3. Body lenght during P3.

Source of variation	df	SS	Ms	
Age	2	128.035	643.517	**
Weight	1	62.9255	62.9255	*
system	1	65.4940	65.4940	*
Age*weight	2	2.54914	1.27457	ns
Age*system	2	8.10623	4.05312	ns
Weight*system	1	3.86883	3.86883	ns
Age*weight*system	2	8.57488	4.28744	ns
Error	60			

* Significant at 0.05

** Significant at 0.01

NS = non significant

Appendix 8.3. ANOVA table with 3 factors for body chest girth during all phases of the reproduction period according to the three factors age, body weight, supplementation or breeding system.

Appendix 8.3.1. Body chest girth during P1.

Source of variation	df	SS	Ms	
Age	2	2438.103	1219.051	**
Weight	1	338.000	338.00	**
system	1	27.7016	27.7016	ns
Age*weight	2	22.0306	11.0153	ns
Age*system	2	51.6799	25.8399	ns
Weight*system	1	2.22605	2.22605	ns
Age*weight*system	2	20.2523	10.1262	ns
Error	60	1825.082	30.4180	ns

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.3.2. Body chest girth during P2.

Source of variation	df	SS	Ms	
Age	2839.060	1419.530	**	2839.060
Weight	241.927	241.927	**	241.927
System	219.5313	219.5313	ns	219.5313
Age*weight	5.47147	2.73573	ns	5.47147
Age*system	76.4740	38.2370	ns	76.4740
Weight*system	0.2222	0.2222	ns	0.2222
Age*weight*system	7.71007	3.85503	ns	7.71007
Error	1825.082	30.4180		1825.082

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.3.3. Body chest girth during P3.

Source of variation	df	SS	Ms	
Age	2	3497.625	1748.813	**
Weight	1	166.805	166.805	**
System	1	130.087	130.087	**
Age*weight	2	16.5542	8.27712	ns
Age*system	2	11.7826	5.89132	ns
Weight*system	1	2.13211	2.13211	ns
Age*weight*system	2	9.41143	4.70572	ns
Error	60	1424.396	23.7399	

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.3.4. Body chest girth during P4.

Source of variation	df	SS	Ms	
Age	3958.861	1979.431	**	3958.861
Weight	150.222	150.222	**	150.222
system	112.500	112.500	**	112.500
Age*weight	1.69444	0.847222	ns	1.69444
Age*system	14.0833	7.04167	ns	14.0833
Weight*system	0.2222	0.2222	ns	0.2222
Age*weight*system	17.6944	8.84722	ns	17.6944
Error	1520.000	25.333		1520.000

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.4. ANOVA table with 3 factors for tail lenght during all phases of the reproduction period according to the three factors age, body weight, supplementation or breeding system.

Appendix 8.4.1. Tail lenght during P1.

Source of variation	df	SS	Ms	
Age	2	705.665	352.883	**
Weight	1	160.474	160.474	**
system	1	65.8578	65.8578	*
Age*weight	2	8.22223	4.111112	ns
Age*system	2	19.9639	9.98196	ns
Weight*system	1	0.651701	0.65170	ns
Age*weight*system	2	9.87924	4.93962	ns
Error	60	611.559	10.1927	

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.4.2. Tail lenght during P2.

Source of variation	df	SS	Ms	
Age	2	461.776	230.888	**
Weight	1	83.4417	83.4417	**
system	1	50.4175	50.4175	*
Age*weight	2	15.6573	7.82867	ns
Age*system	2	13.8581	6.92907	ns
Weight*system	1	7.83420	7.83420	ns
Age*weight*system	2	2.40481	1.20241	ns
Error	60	723.608	12.0601	

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.4.3. Tail lenght during P3.

Source of variation	df	SS	Ms	
Age	2	406.628	203.314	**
Weight	1	104.185	104.185	**
system	1	177.128	177.128	**
Age*weight	2	8.37676	4.18838	ns
Age*system	2	3.45270	1.72635	ns
Weight*system	1	1.99667	1.99667	ns
Age*weight*system	2	1.83420	0.917101	ns
Error	60	860.366	14.3394	

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.4.4. Tail length during P4.

Source of variation	df	SS	Ms	
Age	2	469.313	234.656	**
Weight	1	90.0035	90.0035	**
system	1	175.781	175.781	**
Age*weight	2	15.2569	7.62847	ns
Age*system	2	40.8958	20.4479	ns
Weight*system	1	13.7812	13.7812	ns
Age*weight*system	2	26.0625	13.0313	ns
Error	60	1044.875	17.4146	

* Significant at 0.05
** Significant at 0.01
ns = non significant

Appendix 8.5. ANOVA table with 3 factors for tail circumference during all phases of the reproduction period according to the three factors age, body weight, supplementation or breeding system.

Appendix 8.5.1. Tail circumference during P1.

Source of variation	df	SS	Ms	
Age	2	852.650	426.325	**
Weight	1	355.333	355.333	**
system	1	40.4550	40.4550	*
Age*weight	2	9.47219	4.73609	ns
Age*system	2	30.5749	15.2875	ns
Weight*system	1	0.00623	0.006234	ns
Age*weight*system	2	8.46132	4.23066	ns
Error	60	695.201	11.5867	

* Significant at 0.05
** Significant at 0.01
ns = non significant

Appendix 8.5.2. Tail circumference during P2.

Source of variation	df	SS	Ms	
Age	2	931.627	465.813	**
Weight	2	315.633	315.633	**
system	1	80.7509	80.7509	*
Age*weight	1	8.63021	4.31510	ns
Age*system	2	56.2934	28.1467	ns
Weight*system	2	8.50781	8.50781	ns
Age*weight*system	1	9.04688	4.52344	ns
Error	2	676.073	11.2679	

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.5.3. Tail circumference during P3.

Source of variation	df	SS	Ms	
Age	2	783.117	391.558	**
Weight	2	372.145	372.145	**
system	1	217.049	217.049	**
Age*weight	1	8.40017	4.20008	ns
Age*system	2	57.9731	28.9865	ns
Weight*system	2	6.49801	6.49801	ns
Age*weight*system	1	13.0589	6.52943	ns
Error	2	797.255	13.2876	

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.5.4. Tail circumference during P4.

Source of variation	df	SS	Ms	
Age	2	413.600	206.800	**
Weight	2	221.551	221.551	**
system	1	197.673	197.673	**
Age*weight	1	65.3358	32.6679	ns
Age*system	2	58.3553	29.1776	ns
Weight*system	2	0.0112500	0.011250	ns
Age*weight*system	1	7.18083	3.59042	ns
Error	2	995.458	16.5910	

* Significant at 0.05

** Significant at 0.01

NS = non significant

Appendix 8.6. ANOVA table with 3 factors for tail volume during all phases of the reproduction period according to the effects of age, body weight and management on tail volume .

Appendix 8.6.1. Tail volume during P1.

Source of variation	df	SS	Ms	
Age	2	5852.810	2926.405	**
Weight	1	2729.620	2729.620	**
system	1	2898.904	2898.904	**
Age*weight	2	5679.781	2839.891	**
Age*system	2	5656.702	2828.351	**
Weight*system	1	2873.578	2873.578	**
Age*weight*system	2	5685.551	2842.775	**
Error	60	52.4407	0.874012	

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.6.2. Tail volume during P2.

Source of variation	df	SS	Ms	
Age	7.12026	3.56013	**	7.12026
Weight	1.00820	1.00820	**	1.00820
system	0.322672	0.322672	*	0.322672
Age*weight	0.0289583	0.0144792	ns	0.0289583
Age*system	0.218186	0.109093	ns	0.218186
Weight*system	0.0410889	0.0410889	ns	0.0410889
Age*weight*system	0.073519	0.0367597	ns	0.073519
Error	5.09387	0.0848978		5.09387

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.6.3. Tail volume during P3.

Source of variation	df	SS	Ms	
Age	2	713.711	356.856	**
Weight	1	297.314	297.314	**
system	1	309.129	302.129	**
Age*weight	2	671.121	335.561	**
Age*system	2	683.416	341.708	**
Weight*system	1	327.467	327.467	**
Age*weight*system	2	675.570	337.785	**
Error	60	36.0706	0.601177	

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.6.4. Tail volume during P4.

Source of variation	df	SS	Ms	
Age	2	2.83801	1.41901	**
Weight	1	0.724006	0.724006	*
system	1	0.696200	0.696200	*
Age*weight	2	0.0010111	0.0005055	ns
Age*system	2	0.373900	0.186950	ns
Weight*system	1	0.0024500	0.002450	ns
Age*weight*system	2	0.484900	0.242450	ns
Error	60	7.62650	0.127108	

* Significant at 0.05
** Significant at 0.01
ns = non significant

Appendix 8.7. ANOVA table with 3 factors for body condition score during all phases of the reproduction period according to the three factors age, body weight, supplementation or breeding system.

Appendix 8.7.1. Body condition score during P1.

Source of variation	df	SS	Ms	
Age	2	1.92	0.96	*
Weight	1	3.55	3.55	**
system	1	0.15	0.15	ns
Age*weight	2	0.48	0.24	ns
Age*system	2	0.04	0.024	ns
Weight*system	1	0.22	0.22	ns
Age*weight*system	2	0.11	0.055	ns
Error	60	13.87	0.23	

* Significant at 0.05
** Significant at 0.01
ns = non significant

Appendix 8.7.2. Body condition score during P2.

Source of variation	df	SS	Ms	
Age	2	1.911	0.955	**
Weight	1	1.680	1.680	**
system	1	0.500	0.5000	ns
Age*weight	2	0.428	0.2144	ns
Age*system	2	0.015	0.0078	ns
Weight*system	1	0.0034	0.0034	ns
Age*weight*system	2	0.282986	0.1414	ns
Error	60	9.14583		

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.7.3. Body condition score during P3.

Source of variation	df	SS	Ms	
Age	2	0.978	0.489	*
Weight	1	0.498	0.498	ns
System	1	2.98	2.980	**
Age*weight	2	0.25	0.12	ns
Age*system	2	0.011	0.0059	ns
Weight*system	1	0.15	0.15	ns
Age*weight*system	2	0.53	0.26567	ns
Error	60	8.5634		

* Significant at 0.05

** Significant at 0.01

ns = non significant

Appendix 8.7.4. Body condition score during P4.

Source of variation	df	SS	Ms	
Age	2	0.5277	0.26	ns
Weight	1	0.013	0.013	ns
System	1	2.34	2.34	**
Age*weight	2	0.5277	0.263	ns
Age*system	2	0.1944	0.097	ns
Weight*system	1	0.6805	0.680	ns
Age*weight*system	2	0.1944	0.09722	ns
Error	60	15.500	0.25833	ns

* Significant at 0.05
** Significant at 0.01
ns = non significant

Appendix 8.8. ANOVA table with 3 factors for analysis of pregnancy according to the three factors age, body weight, supplementation or breeding system.

Source of variation	df	SS	Ms	
Age	2	12.1944	6.09722	**
Weight	1	0.347222	0.34722	*
System	1	0.125000	0.125000	*
Age*weight	2	0.36111	0.180556	*
Age*system	2	0.083333	0.0416667	ns
Weight*system	1	0.0138889	0.013889	ns
Age*weight*system	2	0.0277778	0.013889	ns
Error	60	4.50000	0.075000	

* Significant at 0.05
** Significant at 0.01
ns = non significant